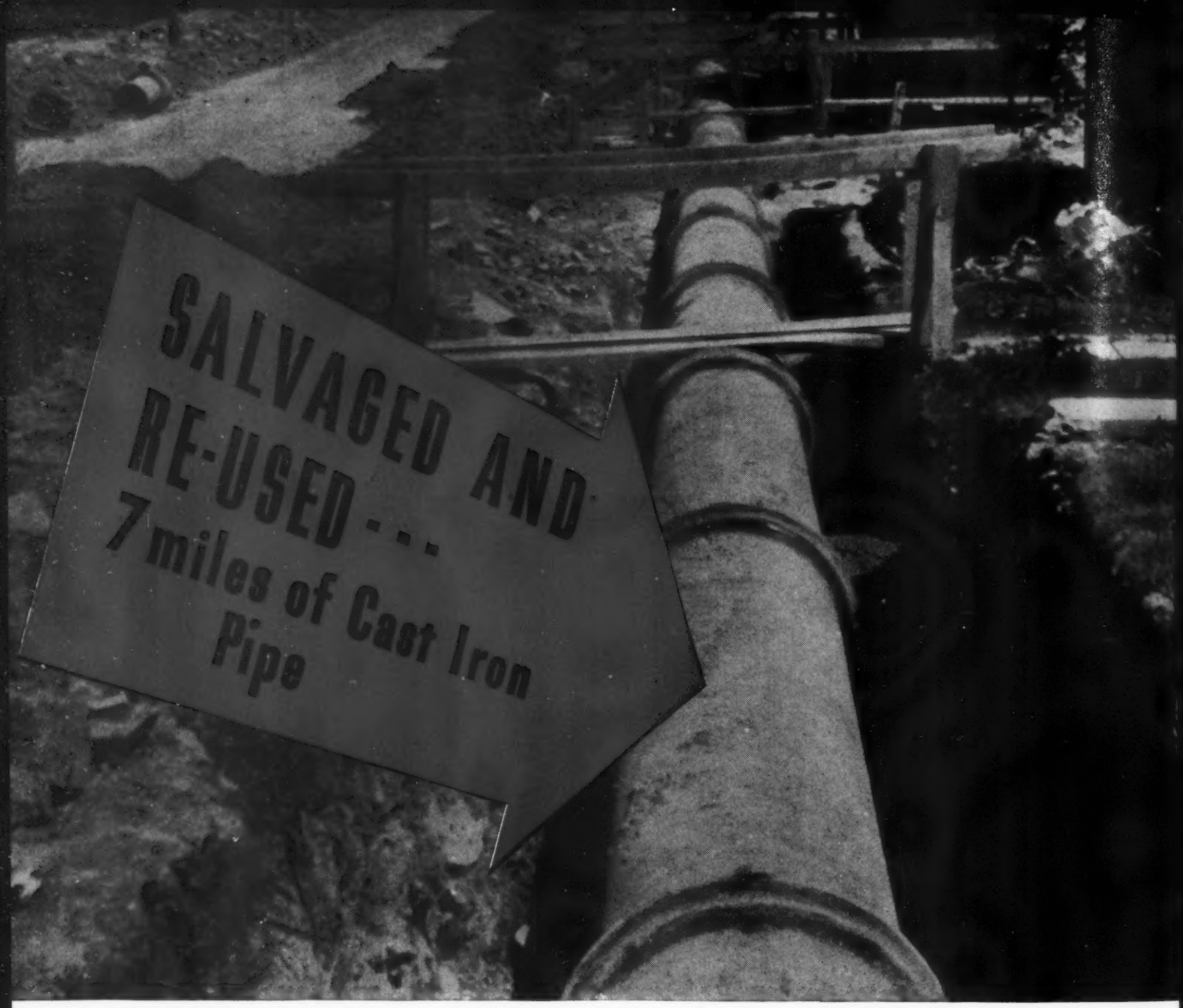
SEPTEMBER, 1942

PUBLIC WORKS

Streets and Highways . . . Water Works
Sewage Disposal . . . Airports



Relocated 36-inch cast iron pipe at Reading,

READING, PA. wanted the new highway even if it meant abandoning a seven-mile-long water main which had to be re-routed. The cost of a new cast iron line would have been approximately $350,000.

Fortunately, the original line was cast iron. It could be salvaged and re-used. It was. Seven miles of 30- to 40-year old cast iron pipe in 24-inch, 30-inch and 36-inch diameters were taken up, reconditioned and re-located. The taxpayers of thrifty Reading were thereby saved a large amount of money. This is a strik example of the salvage and re-use value of cast iron pi But there are numerous other examples in the files of Cast Iron Pipe Research Association.

It is impossible to foretell future requirements or po lation shifts in metropolitan cities but any public offi can be sure that, when water or sewer mains must be ab doned or re-routed, the pipe can be salvaged or used, *if it is cast iron pipe.*

Pipe bearing this mark is cast iron pipe.

TRADE MARK REG.

Available in diameters from 1¼ to 84 inches.

CAST IRON PIPE RESEARCH ASSOCIATION, THOMAS F. WOLFE, RESEARCH ENGINEER, 1013 PEOPLES GAS BUILDING, CHICAGO, ILLI

CAST IRON PIP

PUBLIC TAX SAVER NO. 1

THE WAR EMERGENCY

Safeguarding Health vs. Wartime Waste

Utilization of by-products is especially desirable in times such as these, but their utilization should not be at the expense of health. For instance, sewage sludge is a good fertilizer and may be used to advantage in many places. However, recent experiments by the National Institute of Health have shown clearly the danger of spread of hookworm and certain other body worm diseases by sludge. These experiments have even indicated that digestion at the usual temperatures in heated digesters and subsequent prolonged drying on sludge beds do not kill cysts or, in some cases, ova. In the usual Northern city, where there are relatively few people infected, the danger is not great; in our Army camps where soldiers from all sections of the country are stationed, the danger may be very real. In the south, where efforts to combat hookworm have been vigorously prosecuted for 30 years, the matter may be a serious one from the health viewpoint. If sludge is to be utilized safely, higher digestion temperatures may be necessary, or sludge drying by the flash or other high-temperature process.

Disposal of garbage by hog feeding is another practice that flourishes in war-time for which very little can be said from the economic standpoint—and nothing at all from the aesthetic and health angles. This method has been adopted in many army camps and cities that already have satisfactory incinerators. In addition to the creation of a health hazard through trichinosis and the establishment of a nuisance without peer, there often is an actual out-of-pocket cost. Incinerators are designed to burn mixed refuse, and to operate within a certain temperature range. When the edible portions of the garbage are separated out and sold, the residue which is burned is so low in moisture that excessive heat is generated, burning out the incinerator grates with painful regularity, besides often injuring the incinerator in other ways. The income from the sale of garbage will not begin to pay for the necessary repairs.

And personally we prefer corn-fed pork.

Register Your Construction Equipment

The War Production Board on August 31 issued an order making it mandatory that *every owner* of used construction equipment register it with the WPB on or before September 30, using WPB form 1159. It is also ordered that the owner notify WPB within one week after any used construction equipment is (1) moved from the project on which it is being used; (2) becomes idle after completing its work on that project, even if not moved; (3) is put into use on a project; or (4) has had its ownership changed; using WPB form 1333. Those failing to report truthfully according to this order are subject to fine and imprisonment.

WPB in July completed an inventory of mobile road construction equipment owned by states, cities, counties and townships. This indicates that such publicly owned equipment comprises 16,693 tractors, 16,773 motor graders, 16,005 pull type graders, 4,958 scrapers and carryalls, 3,250 maintainers, 1,382 angle and bulldozers, 25,347 snow plows, and varying amounts of 27 other classes of equipment. This is believed to be sufficent road construction equipment for all subdivisions of governments for at least two years to come, and state highway departments and local agencies can no longer expect priorities assistance in obtaining new equipment.

Water and Sewerage Projects in War Production Centers

FWA Region No. 1 has notified public officials of that region that if they wish Federal aid in the construction of water, sewerage, hospital, school or other war public works project facilities, they should send project applications to the WPA State Offices for preliminary examination before submission to the FWA Regional Office in New York or the Sub-Regional Office in Boston for action by the Regional Review Board. By utilizing the services of WPA administrative personnel and engineers who are familiar with local needs, it will be possible to speed up the work of processing applications and eliminate those not directly connected with the war effort.

Applications must be restricted to projects essential to the war effort and require endorsement of the Army, Navy, or Maritime Commission. After approval in Washington and the allocation of funds authorized by the President, the project still must meet the war-time criteria applied by the War Production Board in assigning priority ratings.

Street Rails as Scrap Metal

It was reported by WPA that up to July 1, 44,900 tons of steel rails had been removed from city streets through WPA projects under agreement with city governments to ship the rails to points designated by the War Production Board. The salvaging of old car rails has been stepped up recently, nearly 30 per cent of the nine-month total having been removed in June. Rail removal has been reported in 34 states since last October, with Ohio producing 10,500 tons in that period and Massachusetts and Indiana following with 3,100 tons each. Northern California has provided 2,900 tons, Upstate New York 2,600 tons, and Iowa and Kentucky 2,400 tons each. During June, Ohio yielded 2,800 tons, Massachusetts 1,600 and Michigan 1,250.

Lay in Soda Ash and Caustic Soda Supplies

WPB now permits unlimited storage, by users, of soda ash and caustic soda and recommends that they take advantage of the present abundance of these materials against future increased demands by manufacturers.

PUBLIC WORKS Magazine . . . SEPTEMBER, 1942

VOL. 73. NO. 9

Applying ½-inch pea stone to freshly applied asphalt seal coat. The truck is backing.

Maintenance of Bituminous Macadam Surfaces

By JAMES E. LAWRENCE

Maintenance Engineer, Massachusetts Department of Public Works

Outline of the latest methods employed by the Massachusetts Department of Public Works in constructing and maintaining bituminous macadam asphalt surfaces.

THE Massachusetts Department of Public Works has specialized for many years in the development of a bituminous macadam asphalt surface of a high type, but retaining the advantages of low initial and maintenance costs. Specifications for construction are varied from time to time as new ideas are developed and as experience dictates, but the basic principle of a flexible pavement constructed of broken stone and bituminous materials incorporated together by penetration methods still holds. The development of the bituminous macadam asphalt pavement would not have been possible without the use of heavy grades of bitumen and the development of the pressure distributor, which permits uniform application and penetration of the bituminous material.

In view of the close relation of maintenance to proper construction and its dependence on it, the following outline of latest construction methods of bituminous macadam asphalt pavements is set forth.

An adequate foundation with the sub-soil properly drained and stabilized must be provided in order to avoid frost heaves, boils, or other distortion of the road surface. Where necessary, 12″ or more of the sub-soil is removed and clean, sandy, bank-run gravel is placed in 6″ layers and thoroughly rolled. In some cases an adequate foundation is provided by a 4″ layer of sandy gravel overlaid with 8″ to 10″ of stone fill thoroughly rolled.

A broken stone base course usually 4½ ins. thick is specified for state highway work. The stone should have a maximum allowable wear of 35% by the Los Angeles abrasion test (A.A.S.H.O. Standard Method T-96-38), and should be composed of 2¼-in. stone or a combination of 2¼-in. and 1½-in. stone. If the latter mixture is used, it should consist of not more than 40% 1½-in. stone. The shoulders should be built of sufficient width and height to hold the stone in place and should be rolled with the foundation course, the base course, and the top course. The stone should be spread and rolled to a true cross-section of the finished road, any depressions or irregularities being covered with additional stone and rerolled until the surface is true and unyielding. The course is then bound with clean sand or stone dust, the rolling operations being continued and the sand being applied in small quantities until it is just below the top of the stones. The rolling should be done with a 12-ton roller.

The top course is usually constructed 2½ ins. thick, and 2¼-in. broken stone of a harder quality than the stone used in the base course is specified. This should

Close-up showing texture of finished surface after treatment.

General appearance of bituminous macadam asphalt after surface treatment.

have a maximum allowable wear of 25% by the Los Angeles abrasion test. The stone is spread and rolled to a true cross-section of the proposed road in a manner similar to the method used in rolling the base course, until the surface is true and unyielding. Excessive rolling which would tend to crush the stone should be avoided. Before any bituminous material is applied, all dirt or other foreign substances must be removed from the surface and any unsuitable broken stone must be removed and replaced with clean stone. The stone should be perfectly dry before the bituminous material is applied.

The bituminous material is uniformly applied on the top course of stone by means of a pressure distributor capable of spraying, if required, for a width of 15 feet at a pressure between 40 and 60 pounds per square inch. The rate of application is 1½ gallons per square yard. The surface is then covered with ⅝-in. key stone, the stone being spread in light applications as the rolling continues, and ½-in. pea stone is then added in sufficient quantity to fill the voids completely. Before the seal coat is applied, any surplus stone is swept from the surface. The seal coat is then applied in the same manner as the penetration coat but in two applications at the rates of ½ and ⅜ gallon respectively per square yard. The first application of bitumen is covered with ½-in. pea stone in sufficient quantity to take up excess bitumen, and the surface given a thorough rolling. After the second application of bitumen, sufficient ⅜-in. pea stone is spread to take up all excess bitumen and the surface given a final rolling. After the seal coat is applied, any surplus bituminous material on the shoulders is removed in order to permit the shoulders to be rolled in conjunction with the finished surface.

The Massachusetts Department of Public Works has used asphalt to a much greater extent than other bituminous materials. The top course of broken stone is penetrated with asphalt cements (A.A.S.H.O. designation M-20-26), 85 to 100 penetration being specified for the summer months, and 100 to 120 penetration in the spring and fall. A quick setting type of asphalt emulsion (A.A.S.H.O. designation M-51-37) is used for the seal coat.

In the interest of elimination of noise caused by the passage of fast-rolling pneumatic tires over the road surface, which has been the principal criticism of the bituminous macadam pavement, the seal coat is made in two applications under recently adopted specifications, instead of one as formerly. The use of the smaller ⅜-in. stone in the second coat, together with the application of two coats instead of one, eliminates the open texture appearance of the finished surface and reduces noise to a minimum.

Maintenance

That the maintenance of bituminous macadam pavement is an important factor in the Massachusetts Department of Public Works Maintenance Department is indicated by the number of square yards of this type of surfacing compared to other types. Altogether there are approximately 30,000,000 square yards of State highway surfacing in Massachusetts. Of this amount, 16,500,000 square yards are bituminous macadam. The bituminous macadam surfacing is composed of approximately 15,500,000 square yards of asphalt macadam and 1,000,000 square yards of tar macadam.

The ordinary maintenance surface cost per square yard per year, averaged over the 5-year period from 1936 to 1940, inclusive, of the more common types of surfacing in use by the Department is as follows:

Type of Surface	*Aver. Maint. Cost per s. y. per year, 1936 to 1940 inc.*
Sheet concrete (reinforced concrete base course with plain concrete surface course separated by a layer of burlap)	$0.0029
Dual type (2 outside lanes of reinforced concrete, middle lanes bituminous macadam asphalt)	0.0035
Bituminous concrete	0.0066
Reinforced concrete	0.0070
Bituminous macadam asphalt	0.0076
Granite block	0.0079
Road mix	0.0118
Obsolete types	0.0310

Maintenance cost of bituminous macadam asphalt at $0.0076 per square yard is slightly higher than it has been running in the past. This is due to the

Newly constructed asphalt macadam with an open type of surface.

number of surface treatments applied to bituminous macadam asphalt surfaces during the past few years, and it is not expected that this trend will continue. In spite of the slightly higher maintenance costs of the past few years, this type of surface is considered very economical in view of the low initial cost of the pavement. Averages of construction costs of bituminous macadam asphalt surfacing, including the base course, in recent years indicate a cost of about $1.10 per square yard.

The amount of maintenance work necessary on a well-built bituminous macadam asphalt road is small, a mile of thirty-foot road requiring a yearly average outlay of a little over $130. I am familiar with many miles of bituminous macadam asphalt pavement 20 to 25 years old still in excellent condition, some of which have never received a surface treatment. Occasionally, however, due to an extremely open surface type of construction or to years of subjection to fast-moving traffic, a surface treatment becomes desirable.

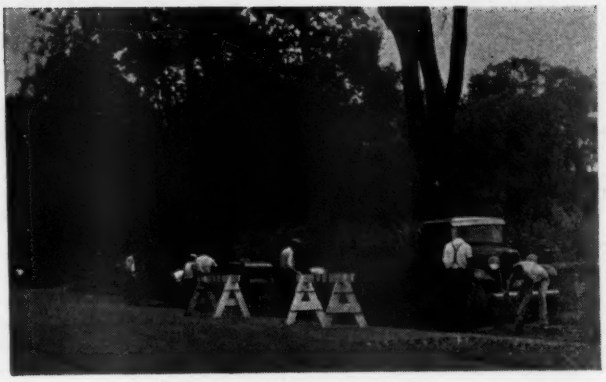
The open surface type of construction was developed as the result of an attempt to secure an extremely non-skid surface by the use of a minimum of pea stone at the time of penetration, leaving the 2½-in. stone exposed as a wearing surface. In this attempt the surface was sometimes inadequately sealed, resulting in the need for surface treatments after a few years. The construction of this type of surface is the cause of the recent increase of surface maintenance costs for

Newly constructed asphalt macadam showing closely sealed type of construction.

bituminous macadam asphalt. The present tendency is to use more pea stone so as to insure the complete filling of the voids and to attain thereby a tighter surface. It is now felt that with the development of the double seal coat the surface thus attained is just as skid proof, much less noisy, and certain to wear longer before a surface treatment is needed than the more open type of surface.

A close examination of a bituminous macadam asphalt road needing a surface treatment reveals a honeycombed surface no longer tightly sealed against the elements. If a surface treatment is not immediately applied, the 2½-in. stones begin to work loose and raveling of the surface commences. Before a surface treatment can be made it is necessary to patch areas where raveling has occurred and bring the road to a true cross-section.

Various grades of bituminous material are used in patching asphalt macadam surfaces. In the early spring, in cold wet weather, temporary patches are made with a premix material composed of broken stone aggregate which is varied in size according to the size of the hole to be patched from about 1½-in. stone down to ¼-in. stone, and cold patch tar. In warmer weather similar premix patches of small areas are sometimes made, using rapid curing cut-back asphalt of relatively low viscosity instead of the cold patch tar.



Patching an asphalt macadam surface.

Under favorable weather conditions permanent patches are made of asphalt cement (A.A.S.H.O. designation M-20-26) to match as nearly as possible the texture of the surrounding surface. All loose material is removed from the area to be patched, and the resulting cavity is carefully cleaned. The area is generally painted with the bitumen, and broken stone graded to the requirements of the area deposited therein. The stone is thoroughly tamped or rolled and keyed and the bituminous material (frequently 85 to 100 or 100 to 120 penetration grade) potted in or applied with a spray unit.

Except to correct for roadbed settlements or settlements due to excavating for underground public utility structures, patches of more than 2 or 3 square feet in area are seldom necessary on asphalt macadam surfaces. If they become necessary, the surface course is entirely removed and a new surface is built up from the base course exactly as in new construction work. The area to be patched is laid out by the use of a chalk line or straight edge, and the edges cut vertically with square corners. A tack coat is generally applied to the edges before the broken stone is placed.

The unit cost of a patch of this type varies not only with the location, which is a factor of the material cost, but with the size and proximity of one patch to another. The cost would vary upward from a low of about $1.50 per square yard.

Before the surface treatment application which is made after completion of necessary patching, all sand and other undesirable material must be removed from the road surface. If considered necessary, the road is swept with mechanical sweepers or with hand push brooms.

Rapid curing cut-back asphalt (A.A.S.H.O. designation M-81, latest revision), grade RC-3, is used with a great deal of success in the spring and fall, and grade RC-4 in the summer. Asphalt emulsion (A.A.S.H.O. designation M-51-37) is also highly recommended.

The surface treatment application is made at a rate of from 0.20 to 0.40 gallons per square yard, the rate having been previously determined by examination of the road. Pea stone, 1½-in. size, is spread over the freshly applied asphalt at a rate of from 20 to 40 pounds per square yard, depending also on the previously determined condition of the road and the quantity of asphalt applied. If further refinement is considered necessary, the pea stone is more evenly spread over the surface before rolling by use of a strip of close woven wire fencing 6 to 8 ft. wide and 8 to 10 ft. long dragged over the surface. The road is then rolled just enough to insure the settlement of the pea stone into the interstices between the larger stones, and to smooth out and thoroughly compact the surface treatment

(Continued on page 26)

Fundamentals f

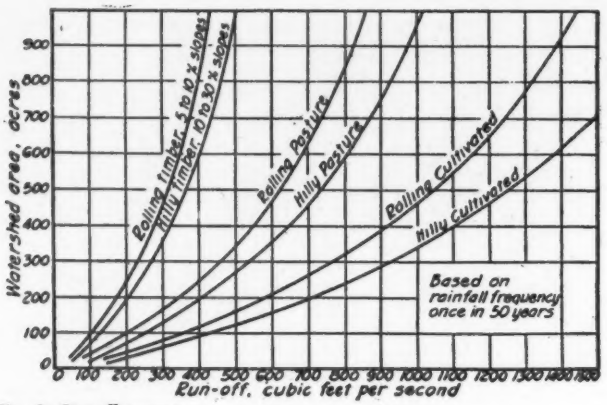


Fig. 2—Runoff curves for small areas

MANY engineers are called on occasionally to construct dams to be used for water storage, water conservation, recreation and other purposes, which are so small as to seem not to warrant the employment of a specialist in their design. Only a few texts on such small dams are available, though it is a subject of great importance and wide interest. Moreover, any dam that by failure may cause extensive property damage or loss of life, should be carefully designed and properly built. It is our aim to provide in the following a good working text for our readers, and to refer them to such more complete material as cannot be included in these pages.

1. *Introduction.* — The term "low dams" is an indefinite one but in this article is intended to include structures up to about 20 ft. high. The principles given herein, however, may be applied, especially under favorable conditions, to higher structures. As a matter of fact, the height of a dam is not a criterion of its importance or of the research and skill needed to design it. Potential damages from failure and such local features as foundation and soil conditions are usually the governing factors in design.

Preliminary Investigations

2. *Gathering the Data.* — The first step in determining the need for the dam, the possibility of constructing it and the factors governing its design is the collecting of essential information on the various phases of the project. The following outline indicates some of this essential information:

a. *Location and Other Maps.* — A location map should be procured or (if not available) prepared. This should show the general location of the project; highways and railroads that may be affected; railroad shipping points in case material must be shipped in; nearby power lines; and other information of a similar nature. U. S. Geological Survey Maps, if available, are excellent for this purpose. This location map should show, if possible, the area of the watershed above the proposed dam site. A topographic map should be prepared showing the reservoir basin, on which should be indicated property lines and land ownership.

b. *Water Rights.* — Thorough investigations should be made of the status of water rights. In the eastern part of the United States, this is not usually a problem, but in the more arid areas where water is valuable, it may be a determining factor.

c. *Hydrologic Data.* — Long-time records of the flow of the stream are desirable but, especially in the case of small streams, very rarely available. The runoff may be computed, using the standard methods found in text books.[1] To be even approximately accurate, this method must be based on rainfall records for a considerable number of years. Flood flows are considered under another heading, but high water marks should be sought and information gathered as to dates, influence of ice, and other factors. Several cross-sections of the stream channel showing water surface elevations should be made above and below the proposed dam site.

d. *Dam Site.* — A detail topographic map of the valley in the vicinity of the proposed dam site should be prepared, on a scale of about 50 ft. to the inch, and covering sufficient area up and down stream to

[1] Water Supply and Purification, Hardenbergh, pp. 79-88.

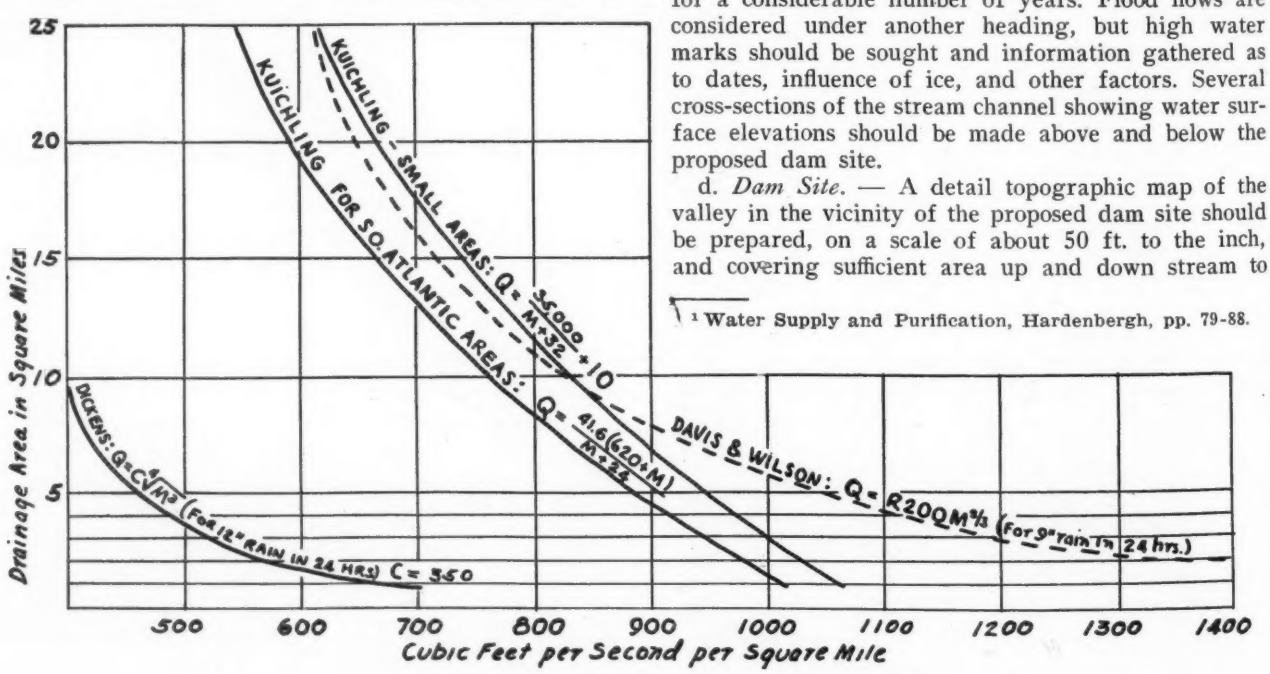


Fig. 1—Runoff by various formulas for smaller watersheds.

ls f signing Low Dams

By "low dams" is meant those not over 20 feet high. This is the first of a series of articles setting forth the general principles and procedures for designing such dams.

Rock Creek watershed of the Corvallis, Oregon, water supply.

provide information for definitely locating the site, with outlets and spillways. Notations should be made as to rock, gravel, or other features that might affect design. The locations of test pits and drill holes should be shown on the map (directions for sinking pits and holes will be given later), indicating subsoil and rock conditions. A complete and accurate record of such subsurface conditions should be made, showing types of materials and underground water levels in the areas under and adjacent to all structures.

e. *Material.* — Possible sources of material to be used in constructing the dam should be investigated, including both quality and quantity. If the dam is to be of concrete, sand and coarse aggregate should be sought and their suitability for use determined; if an earth dam is contemplated, the area from which the material will be taken, its extent, and data on quality should be obtained. Laboratory tests of soils are almost a necessity. Reliable dams cannot be built of clay alone, or of silt, or of sand, but require, for tightness and safety, a balanced mixture of the three. Some types of soil are of such a nature that they cannot be consolidated. If no laboratory is available locally or through the county or state highway department, the Editor will refer readers to adequate soils laboratories.

f. *Local Conditions Affecting Design.* — Investigations should be made and data recorded covering the need for a roadway across the dam; availability of power for construction; necessity of fish protection measures or fish ladders; permanent buildings; winter conditions; spillways; outlets and their capacity and elevation; construction roads; stripping of reservoir area; mosquito control (some states require alternate raising and lowering of the water level to prevent mosquito breeding); requirements for construction camp, if any, its site, and the number of men needed; facilities for water supply and sewage disposal during construction; hauling of materials; possibility of flood damage to work during construction; and equipment required.

g. *Sanitation.* — Facilities for proper waste disposal and for safe water supply must be made, both for the construction forces and for the permanent operating personnel, if any. Also, if the lake is to be used as a resort, adequate water supply and sewage disposal will be needed to care for peak loads. The

State Board of Health will advise on this. If used for bathing, some provision for chlorinating the water in the bathing area should be made unless there is a considerable flow in the area. Bathing and swimming areas should not be too deep; and, where possible, should be protected against algae growths. Consideration may be given to a bituminous paving, or to some other means of preventing interference by such organisms.

h. *Other Data.* — A copy of the State regulations governing approval of dams should be obtained. There is no fixed policy among the states regarding the department or commission that is responsible. In many states, there are two or more sets of regulations issued by different bodies, as the Department of Public Works and the Department of Conservation. Often the State Board of Health must be consulted. The information at hand from the various states is too bulky for reproduction, or even abstracting, here. Application for information should be made to the Secretary of State of the State in which the dam is to be built.

3. *Report.* — The above will serve as a general outline for a report on the project, except for the design factors, which have not yet been touched upon. These factors may include purpose for which the reservoir is intended; amount of storage; water surface elevation and head on dam; height of dam; freeboard; spillway and outlet design data and capacities; general dimensions and details of the dam; and cost.

4. *Test Pits and Borings at Dam Site.* — Exploration of subsurface conditions is imperative, even on small dams. To do this properly, when considerable depths must be investigated, is often costly. A drilled well or a washed well does not give information that is of appreciable value. Driving an iron bar or rod down to rock is also of practically no value. A core drill gives reliable data, but is often too expensive for the small project. The methods of values practicable for the small project include test pits dug by hand and use of the earth auger.

a. *Using the Earth Auger.* — Simple hand augers may be used for shallow investigations. A casing may or may not be used; for maximum depths at which a soil auger can be used, the type of soil will determine the need for the casing. The auger is screwed into the soil and then pulled out full of material. This is examined and noted on the log or record and the process continued, the depth of each sample being carefully noted. In dry sand soils, this method will not work, although pouring water into the hole may give the sand enough cohesion to bring it out with the auger. Clays and silts can be brought up from below the water table (the depth of which should be recorded), but sands usually cannot. The presence of boulders or of coarse gravel may prevent the use of this method. When a casing is necessary, its inner diameter should be only slightly larger than the outside of the soil auger. A number of holes should be sunk on, above and below the area to be covered by the dam. Ground water elevations, the surface of bed rock and the character of the strata, especially porous strata, should be noted with reference to the engineering datum elevation, so that these various subsurface features can be indicated on the dam profiles.

b. *Test Pits.* — It is difficult to sink test pits more than 6 or 8 feet deep unless (1) they are sheeted to protect the workmen and (2) mechanical means for removing the dirt are provided. Pits should be at least 4 ft. square in order to permit a man to work in them; generally a square pit is preferable to a round one as it is easier to sheet. Removal of the excavated material can be accomplished, on small jobs, by a hand-operated winch and a small bucket. On larger jobs a crane or engine-driven hoist should be provided. Ratchets should be provided to prevent dropping of the bucket; or, where a small one is used, it may operate in skeleton timber guides. Some provision should be made for dewatering the pit. Soil auger borings made in advance may be valuable in ascertaining the depth to ground water. For shallow pits (less than 15 or 18 ft.), gasoline-driven centrifugal pumps of the portable type, located on the ground surface, are excellent. With greater depths, the pumps may have to be placed in the pit, in which case a 4-ft. square pit may not provide sufficient working space.

c. *General.* — If the location of the dam has been definitely fixed by purchase or by the natural features of topography, borings and test pits should be started at once on the site. If more than one location for the dam seems possible, each should be thoroughly investigated by pits or other means. Money spent on subsurface investigations is well spent and often saves much future embarrassment and expense. A recent earth dam in South Carolina, which was about 12 ft. high, illustrates this point. Subsurface investigations were not made. Due to an underlying sand stratum, sand boils occurred before the lake could be filled to capacity. When these were repaired, others developed. Despite costly curative work, the reservoir can not yet be filled.

d. *Conclusion.* — Pits or borings should normally be made at 10 to 25-ft. intervals along the center line of the dam, and elsewhere if indicated by local conditions. At least five pits or borings should be made. These should be to rock or to a depth equal to 75% of the maximum depth of water to be contained by the dam.

Designing the Dam

5. *Types of Small Dams.* — Most small dams are of earth, or of gravity-section concrete or masonry — that is, of such shape, size and weight as to resist the thrust of the water without recourse to arch or similar action. Some timber crib and a very few small rock-fill dams have been built. Most of the information in this article will refer to earth or gravity-section concrete dams. Details of design will be given. However, in all types of dams, ample provision for flood flows is an essential and will be discussed first.

6. *Probable Flood Flows from Small Watersheds.* — For the purpose of limiting the field to be covered, this article will consider watersheds having areas of less than 20 sq. miles. In considering the data given herein, primary weight should be given to the following:

a. The maximum rainfall and runoff cannot be definitely predicted, nor can the time of its occurrence. Records of heavy rains and of runoffs are available in many sections of the country covering 100 years or even more. From these records, formulas have been developed which have proved to be reliable indicators of runoff following rains of a given intensity, and under certain conditions of climate and topography. But greater rainfall intensities may occur; or a rainfall of lesser intensity occurring when the ground is frozen, or when it is covered with melting snow, may cause much greater runoff and correspondingly greater floods.

b. Except in most unusual cases, it is not practicable to provide a spillway designed for the maximum flood

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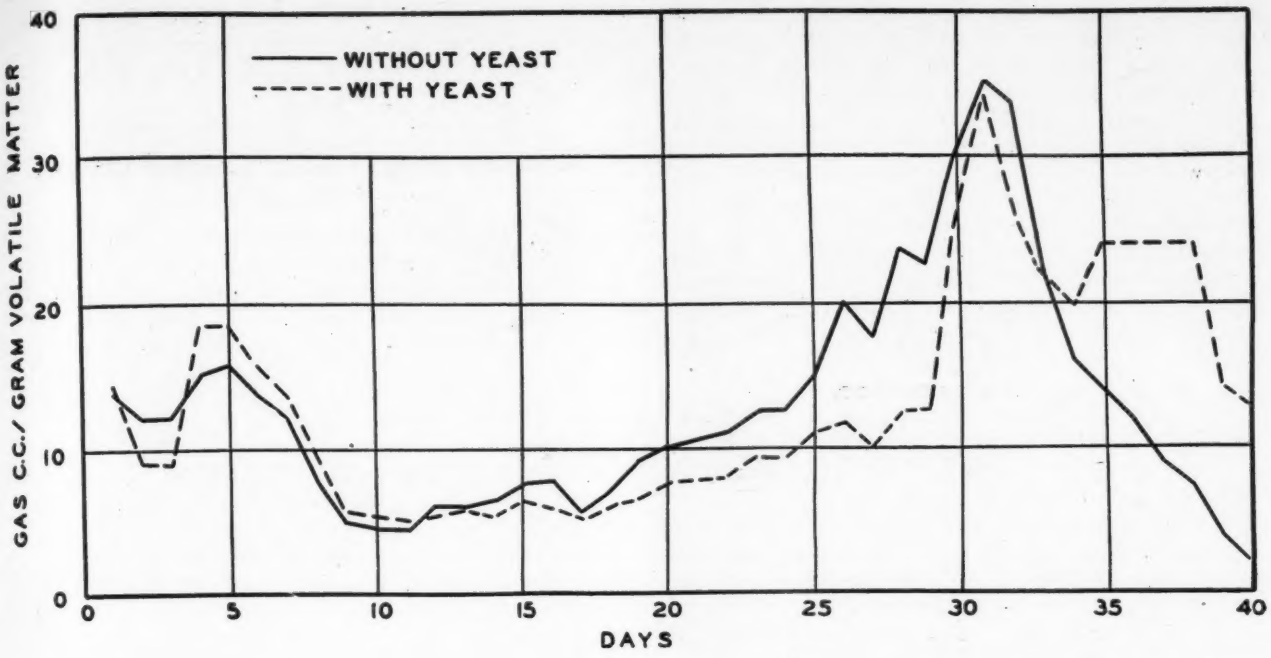


Effect of Yeast on the Stabilization of Sewage and Sludge Digestion

By H. HEUKELEKIAN
Associate, Dept. Water and Sewage Research, New Brunswick, N. J.

Experiments conducted by the department indicate that yeast does not hasten either the stabilization of sewage or the digestion of seeded sludge.

A NUMBER of requests for information regarding the use of yeast for sewage stabilization and as aid in sludge digestion have been received from individuals who want to use it in septic tanks, from sewage operators who have heard that yeast stimulates anaerobic digestion, and from army officials who want to use it for starting new plants or improve the rate of digestion under varying loads.

Yeast multiplies and is active under aerobic and anaerobic conditions. It uses primarily sugars for growth and multiplication in the presence of sufficient other nutrients containing nitrogen, phosphorus, etc. It is conceivable, therefore, that under specific conditions yeast may be a valuable aid for stabilization under aerobic conditions. Under anaerobic conditions, such as those prevailing in septic tanks and sludge digesters, it is not likely that the digestion would be stimulated.

In view of the interest shown, a series of experiments were conducted to determine the effect of yeast on the stabilization of sewage and on anaerobic sludge digestion.

Methods

In the experiments dealing with the effect of yeast on the stabilization of sewage, the yeast was added to the sewage and incubated in open and closed vessels. At intervals samples were taken after stirring the contents of the vessel and the five day B.O.D. determined. In the experiment with closed bottles, after the sample was removed, the bottle was discarded and another bottle used for the next determination. Incubation was at 20°C.

The effect of yeast on sludge digestion was determined by making a fresh solids ripe sludge mixture of 2:1 on the basis of volatile matter and by adding to a portion of such a mixture yeast cake representing 50 per cent of the volatile matter in the ripe sludge. The mixtures with and without the yeast were incubated at 20°C and daily gas measurements made.

The yeast used was a brand of baker's yeast supplied to us by the courtesy of the Annheuser Busch Co.

Results

1. *Effect on sewage.*—The effect on the B.O.D. of sewage, when two grams of yeast were added per liter, incubated in open vessels was as follows:

Table 1. P.p.m. 5 Day B.O.D.

Days	*Without Yeast*	*With Yeast*
0	102	210
1	76	210
2	61	228
3	45	138
5	35	...
6	30	235

No improvement was observed due to the addition of yeast. The initial as well as subsequent B.O.D.

values were higher with the yeast than in the control. After the third day the sewage to which yeast had been added turned black and the B.O.D. increased. The quantity of organic matter added in the form of yeast was several times higher than in the sewage itself and the solution of oxygen from the undisturbed surface was not rapid enough to maintain aerobic conditions. Even if the yeast had some beneficial effect, it was counterbalanced by the anaerobic condition created by the inoculation. In the next experiment the quantity of inoculation was greatly reduced (0.1 gm. of yeast cake per liter of sewage) and the experiment conducted in closed vessels. The results were as follows:

Table 2. P.p.m. 5 Day B.O.D.

Hours	*Without Yeast*	*With Yeast*
0	240	240
24	206	225
48	203	225

The sewage used was fairly strong, and when air was excluded the contents of the bottles with and without the additions of yeast turned black due to hydrogen sulfide production within two days. The results show that the addition of yeast had no beneficial effect on the anaerobic stabilization of sewage.

2. *Effect on digestion.*—To determine the effect of yeast on anaerobic sludge digestion a mixture of fresh solids and ripe sludge was made with a ratio of 2:1 on the basis of volatile matter. To one mixture five grams of yeast cake was added. The results of gas production are presented in Fig. 1 on the basis of c.c. gas per gram of volatile matter in the fresh solids. The mixture containing the yeast produced somewhat more gas during the first twelve days of digestion than the control (134.5 c.c. as compared with 115.5 c.c.). Thereafter the gas production with the yeast mixture lagged behind the control. The peak of gas production in both mixtures occurred on the 31st day of digestion. Whereas the gas production in the control dropped rapidly after reaching its peak to a low value on the 40th day, considerable quantities of gas were produced in the yeast mixture after the peak production. Nearly equal quantities of gas were produced with and without the yeast addition in 40 days (Table 1.). After five days longer incubation about 5 per cent more gas was produced from the yeast mixture than from the control. This might be attributed to the gas produced from the decomposition of the yeast. The reduction of volatile matter was also, however, somewhat higher with the yeast than in the control.

Since yeast does not aid the stabilization of sewage kept under anaerobic conditions and does not increase the rate of digestion of sewage solids in the presence of ripe sludge, it is improbable that fresh solids decomposition would be stimulated. In other words, the addition of yeast to a new digester can not be expected to be of much value, nor improve the rate of digestion under varying loads.

Conclusions

(1) Yeast does not hasten the stabilization of sewage under anaerobic conditions.

(2) Yeast does not hasten the digestion of seeded sludge mixtures.

Effect of Yeast on Volatile Matter Reduction and Gas Production of Seeded Sludge Mixture

	Control	*With Yeast*
Reduction of volatile matter, % in 45 days	31.4	34.6
Gas produced in 40 days, c.c./gm. volatile matter	510	519
Gas produced in 45 days, c.c./gm. volatile matter	526	555

The above, written for PUBLIC WORKS, is a Journal series paper of the New Jersey Agricultural Experiment Station, Rutgers University, Dept. Water and Sewage Research.

Mosquito Control As a National Defense Measure

With the concentration of population groups in the vicinity of army and navy posts and industries operating on defense contracts, it has become apparent that consideration must be given to the control of mosquito breeding areas, from the public health as well as the nuisance point of view. The expansion of industries and concentration of troops may bring persons who have resided in malarial areas and possibly be malaria carriers.

With the concentrations of population, the presence of the carriers of the malaria parasite and the existence of the malaria vector constitute a potential malaria hazard to the population. Furthermore, the pest mosquito, in addition to making living conditions uncomfortable in the vicinity of the breeding areas, may be responsible for a reduction of industrial operations among employees at some of the large industrial plants engaged in filling national defense orders. For example, in the vicinity of the aircraft factory of the Glenn L. Martin Company, there are many salt marshes which constitute a large breeding ground for the salt marsh mosquitoes. It has been reported that many of the mechanics who are obliged to work out-of-doors on the large bombing planes, have been seriously inconvenienced by the large numbers of mosquitoes.

Because it is believed that a mosquito control program is essential for the protection of the armed forces of the Federal government quartered within the State boundaries and for the protection of workers in essential industries to speed up the national defense program the U. S. Public Health Service, through the State Department of Health, has set up a mosquito control program in Maryland for the purpose of controlling mosquito breeding in defense areas only, primarily in the vicinity of the Aberdeen Proving Ground, the Edgewood Arsenal, the Bethlehem Steel Company, the Glenn L. Martin Company, Camp Holabird and the U. S. Naval Powder Factory at Indian Head. The control work will consist of the application of oil to sluggish streams, small ponds and stagnant pools, the clearing of underbrush adjacent thereto and the draining of salt marshes where necessary. The work is being carried on under the supervision of the Bureau of Sanitary Engineering and under the direction of a sanitary engineer detailed thereto by the U. S. Public Health Service. Funds in the amount of $42,000 have been allocated to Maryland for the mosquito control program by the Works Projects Administration. All labor will be furnished by this Federal agency.

From the "Bulletin" of the Maryland State Dept. of Health.

Intake Plugging At Fort Erie, Ont.

An accumulation of plant growth in the intake has been causing trouble with the Fort Erie North, Ont., water supply. On several occasions recently the pumping equipment has had to be shut down while the intake has been given a cleaning. Because of the trouble the water consumers have been urged to use water sparingly. Steps for keeping the accumulations from developing are being considered.

Copper Sulphate for Aquatic Nuisances

Results of studies made in Wisconsin on methods of applying copper sulphate and its toxic effects upon fish life in various concentrations.

IN WISCONSIN, during 1938, there was established, as a result of executive order, a committee to review the problem of control of algae and weeds in streams and other bodies of water in the State; and the 1941 legislature passed an act calling upon the Committee on Water Pollution "to supervise chemical treatment of waters for the suppression of algae, aquatic weeds, swimmers' itch and other nuisance-producing plants and organisms."

The studies of these committees were devoted largely to the use of copper sulphate—methods of applying it to lakes, and its effect upon fish. Some results were given in a paper by L. F. Warrick, F. J. McKee and A. E. Bartsch before the American Chemical Society, from which the following is abstracted.

For applying the copper sulphate to lake surfaces, a 50-gallon wooden barrel having a partition extending from the top to within six inches of the bottom was used as a solution box. Copper sulphate crystals of approximately pea size were placed in the barrel and hot water from the boat engine cooling system discharged into the barrel on one side of the partition. This liquid then passed downward under the partition and into the copper sulphate crystals and upon reaching the other side of the partition was nearly saturated with copper sulphate. A motor-driven portable pump was placed in the boat for the purpose of spraying the copper sulphate solution. Water was drawn from the lake and a small amount of the concentrated copper sulphate solution introduced into the suction side of the pump. In passage through the pump this mixed with the comparatively large amount of lake water and was discharged through two 1" rubber hoses equipped with nozzles which were manually operated to spray the dilute copper sulphate solution onto the surface of the lake. The first treatments were controlled by varying the speed of the boat and the amount of copper sulphate crystals placed in the solution barrel. It was found that this method would dissolve approximately 200 pounds of copper sulphate per hour. Later developments and refinements in this method of treatment included the construction of a speedometer which gave an accurate measurement of the speed of the boat and also the installation of a small Venturi meter which measured the amount of copper sulphate solution being discharged into the suction side of the pump. Later, another baffle was placed in the solution barrel and it was found that it was possible to obtain a saturated solution of copper sulphate which did not vary appreciably in strength.

It was found that the most satisfactory method of controlling variables was by changing the volume of saturated copper sulphate solution fed into the system. In this way the concentration of copper sulphate sprayed onto the surface of the water could be varied in proportion to the speed of the boat so that the resulting concentration in the lake water could be maintained at any desired figure. In hard water lakes, the usual amount of copper sulphate added amounted to 1 p.p.m. in the top four feet of water. At the present time the apparatus is being further developed by the construction of a portable photolometer with which the concentration of copper sulphate solution can be accurately checked.

Fish Studies: The toxicity of copper sulphate to brown trout fry (32—50 mm. in length) was studied. Concentrations ranging from 0 to 200 p.p.m. were made and fish placed in a series of 11 5-gallon aquaria. Water temperature was held at 10—11°C., alkalinity at 248 p.p.m. and frequent checks on dissolved oxygen, pH, and free carbon dioxide were made. All of the fish died within 28 hours in concentrations of 5 to 200 p.p.m. It would appear then that even in very hard water the maximum copper sulphate concentration should be 2.5 p.p.m. when the more sensitive fish are present.

Immersion tests showed that 10 minutes or longer was sufficient in a 10,000 p.p.m. solution to kill large mouth black bass fingerlings in 9½ hours, and 15 minutes exposure killed 70% of the brown trout fry in 10 hours.

Experiment showed that, as measured by time required to cause death, the relative toxicity of 25 p.p.m. copper sulphate to brown trout fry varied inversely with the alkalinity. With 6 p.p.m. alkalinity, all fish died in 2.5 hours, while with 248 p.p.m. alkalinity there were four survivors after 12.5 hours. Less than 1.5 hours are required to kill brown trout fry in distilled water with 50 p.p.m. copper sulphate. Similar results using one of the algae, *Hydrodictyon*, in 2 p.p.m. copper sulphate showed the same relative variation in killing rate.

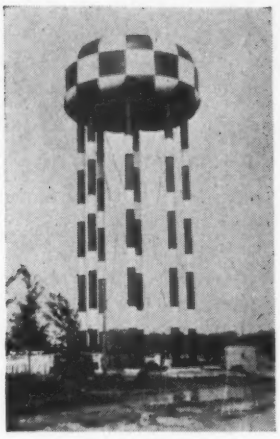
The enormous discrepancy between the accepted toxic dose for bass (2.1 p.p.m.) and that found in the present studies, above 160 p.p.m., was explained as follows: The toxic dose of copper sulphate for several species of fish (black bass, yellow perch, sunfish, and bullheads) was determined in distilled water. The values so obtained agree well with those appearing in the literature. Thus, the conclusion must be drawn that the tests of previous investigators had been made in distilled or very soft water.

Chemical examination of hard water treated with copper sulphate diclosed the fact that the calcium

(Continued on page 47)

Water and Sew Ext

By PETER E. BRENDER



The new elevated tank.

The author and his assistant.

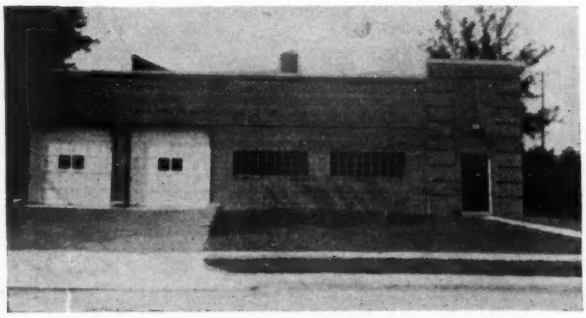
THE village of Wayne, Michigan, is a small community located 17 miles west of the center of Detroit on U. S. Route 112 leading to Chicago, and has experienced the recent rapid growth common to all communities in that area of industrial development. How rapid this growth has been is indicated by the increase in water consumption. The average consumption in 1940 was 400,000 g.p.d.; in 1941 it was 850,000 to 900,000 a day, and has now increased to nearly 1,000,000.

Stimulating this growth has been the presence of two railroads—the Pere Marquette and the Michigan Central—which pass through the village, and good concrete roads extending in all directions. Eight large industrial plants and several small shops are located from walking distance to 30 or 40 minutes driving distance from the village; recently added to by the building of Ford's Willow Run Bomber Plant eight miles away. The Dearborn Coach Co. gives frequent service to the Ford River Rouge Plant and into Detroit. There is a good school system; all the leading denominations have church buildings, and there is a community recreation council.

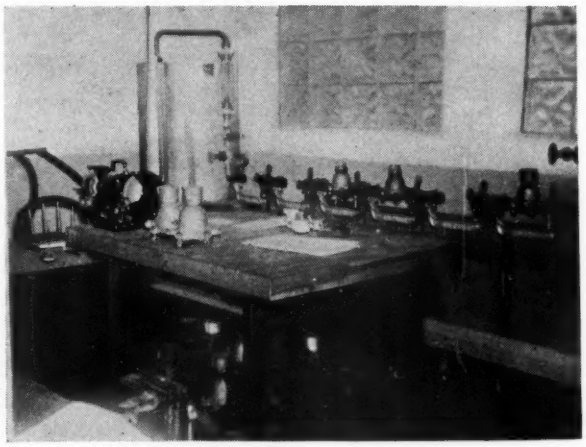
Early in 1940 shortage of housing facilities had developed and the village commission foresaw the necessity of at once increasing its water and sewerage facilities to provide for the expansion which the industrial growth of the area would necessitate, and commissioned the writer to study the requirements and submit recommendations, with estimate of cost, for the extension which should be provided.

The water supply is obtained from the city of Detroit, the village purchasing the water and supplying it through its own distribution system. (Steps are under way for obtaining another larger supply.) As a result of this report a program was set up for extensions to the water and sewerage systems estimated to cost $375,000, to be financed by the sale of revenue bonds. The water extensions included 675 ft. of 16" mains; 13,450 ft. of 12"; 6,166 ft. of 8", and 10,333 ft. of 6"; 50 fire hydrants; and 61 valves. Also a 500,000-gal. elevated storage tank, a Water Board building, and a booster station.

The elevated tank is of ellipsoidal design, supported by eight cylindrical legs 41" in diameter, with a 6 ft. standpipe. The overflow elevation is 132 ft. 6 inches, which gives an average pressure of 52 lbs. The tank location is 13 ft. lower than the center of the village and the booster station is 23 ft. lower. The tank is protected inside with a cathodic rust-proofing system. The exterior is painted in a checkerboard pattern of international orange and white, as a safety measure, as the County Airport is only a few miles distant.



The Water Board building.



Corner of meter test room.

The Water Board building is a one-story building 40 ft. x 60 ft. in size with provision for tools and trucks, and office space for the expanding Water Department. It has face brick exterior and painted cinder block walls. It is heated by forced hot water heat from an oil-burning furnace. The meter test room has a five-compartment cleaning sink with sump and ventilating hood; a five-station meter testing equipment and auxiliary attachments. A 12-inch water supply was run to this building to insure a uniform pressure at all times. Also included in the equipment of this building are a spray booth; work benches; storage bin for meter parts; air compressor for truck and meter service; and a portable gasoline-driven air compressor for the spray of hydrants and movable equipment.

We are now able to test new meters before placing them in service, having facilities for breakdown tests of competitive meters. We have started a testing, repairing and replacing program on all meters within

Extensions for a Rapidly Growing Village

Influenced by the proximity of Detroit, the rapid population growth increased the water consumption 150 per cent in two years. How the great increases in water and sewer demands were met.

the system. There is also a fan for running in meter discs by using a pressure blower with suction and discharge of fan terminals on the work tables, so that the meter repair man can obtain a rotation of a meter disc by simply moving the meter to either the suction or discharge tube. A bench drill and double motor-driven bench wire brush, emery wheel or polishing equipment are available. The meter test area, while not very large, is a complete unit and can be added to as needs arise.

The office work and record side of the Water Department have their share of new equipment, which includes a billing machine and new bill forms; electric addressograph; files for meter records, tapping records and for address plates; desks, chairs, etc.

The booster station in its new location has a 24″ supply and 24″ system piping, and when fully completed will release about 11,000 ft. of 12-inch main now used as a supply for a pressure feeder line, thus giving two 12-inch loops for feeder lines to the village area. Pumps have been installed as follows: one 400-gallon, one 600-gallon and one 800-gallon, each with a 200 ft. head. A venturi meter has been provided, with a capacity range of 430,000 gallons to 5,500,000 gallons per day. The building has a full basement in which all piping to and from the pumps are located. Provision has been made for three more pumps. The heating is forced hot water, with an oil burning furnace.

The sewer extensions include 1,838 ft. of 48″, 2,607 ft. of 42″, 5,154 ft. of 36″, 505 ft. of 30″, 2,058 ft. of 21″, 1,550 ft. of 18″, 3,602 ft. of 15″ and 3,157 ft. of 12″; also 61 manholes and 132 catch basins. These

Office of Water Board.

Interior of booster station.

sewers serve a new area which had been within the village limits for years but had never had public utility service and therefore contained only a few scattered houses. They provide trunk sewers and laterals for 600 to 700 lots for an area as yet unsubdivided.

The water pipe was furnished by the U. S. Cast Iron Pipe Co.; valves and hydrants by the Manistee Iron Works; elevated tank by the Chicago Bridge & Iron Co.; cathodic protection by the Electro-Rustproofing Co.; meter testing equipment by the Ford Meter Box Co.; Venturi meter by Builders-Providence; pumps by American Well Works; gauges by Bailey Meter Co.; fittings by Ann Arbor Foundry Co. The sewers were constructed by Waterways Construction Co. of Detroit; water mains and street replacement by Santucci Construction Co. of Skokie, Ill. The general building contractor was Charles Board, plumbing and heating by W. Wilbur White, and electrical work by Redford Electric Co., all of Detroit.

Hubbell-Roth-Clark were consultants for the entire project. The writer was in charge of the preliminary engineering details, prepared plans and specifications and supervised the installation.

The program was carried out almost exactly as recommended in the original report to the Village Commission. The project was carried to completion without priority ratings, as all contracts were awarded early in 1941 previous to such requirements. We have been delayed at times by the lack of manpower. It is apparent now that had we not undertaken these extensions just when we did, it would have been a long time—several years, perhaps—before we could have obtained the materials either with or without Federal permission, especially the elevated storage tank.

Street Lighting in War Time

Conclusions from two years' experience in England concerning dimming street lights, whitening curbs and trees, motor car headlights, etc.

BLACKING-OUT of buildings is comparatively simple, but for streets the problem is much more difficult. Complete elimination of street lights is almost sure to result in accidents. In Britain, during two years of war, 20,000 people were killed on blacked-out streets. It is difficult or impossible for all pedestrians to reach indoor shelter at once when the alarm sounds or for all vehicles to immediately park along the curb; and some, such as air-raid wardens and repair trucks, are compelled by their duties to use the streets. The conclusions from two years of experience were told by J. S. Dow, Honorary Secretary of the Illuminating Engineering Society (England) in a paper before the Royal Society of Arts and printed in "Highway Research Abstracts." The essential features of this paper are abstracted below.

Screening existing street lamps, producing a downward cone of light, resulted in a multitude of points of light almost as visible from above as the actual street lamps. It was found that what was needed was: (1) fittings so designed that no light was emitted above the horizontal; (2) illumination evenly distributed between lights; and (3) illumination not exceeding a certain maximum.

Extensive experiments led to the conclusion that the order of illumination furnished by the now-familiar war-time street lighting or "synthetic starlight" (approximating to 0.0002 foot-candle) could be provided with safety. It is true that when the very much higher illumination of moonlight (0.01 to 0.02 ft.-c.) is available its effect is but small, but on very dark nights there is all the difference in the world between "synthetic starlight" and complete obscurity—and it is on such nights that some degree of artificial lighting is most vitally needed.

The illumination received from summer sunlight on a clear day may attain 10,000 foot-candles, while the value derived from faint starlight may be of the order of 1/10,000th—a ratio of one hundred million to one. The eye is thus called upon to adapt itself to an amazing range, and in order to make the best use of the meager light available we should take as a starting point the behaviour of the eye under these abnormal conditions.

The conditions of "twilight vision" are well known. Complete dark-adaptation of the eye is only attained slowly, and may be greatly impaired by a momentary flash of light. Hence the need for a period of at least several minutes, in order to enable the eye to function properly when one passes from a brightly lit interior into the external darkness, the importance of avoiding flashes from incautiously directed torches, and the need to keep the brightness of direction-signs below a certain level, which under conditions of war-time street lighting appears to be in the neighborhood of 0.1 equivalent foot-candles.

Of outstanding importance is the accentuation of contrasts between objects and background, for under these "twilight" conditions an object of quite substantial size which reflects only 20 to 30 per cent less light than the adjacent roadway may easily escape recognition. Such devices as the whitening of curbs and the trunks of trees on sidewalks are therefore extremely useful, and the idea might well be more extensively practiced, especially at important crossings, safety islands, roundabouts, etc. One step which we can all of us take—and which we have all of us from time to time been urged by the authorities to take—is to increase the contrast between ourselves and our background by wearing or carrying some white object of substantial size when using the streets by night.

Obscuring lamps with blue lacquer has no advantage to compensate for its many drawbacks which would justify the adoption of colored light in place of white for a general system such as war-time street lighting.

Other problems are the design of masks for motor-car headlights, the production of standard civil defense signs and their illumination, the qualities of fluorescent and phosphorescent paints and the contriving of "light locks" to enable people to pass in and out of illuminated interiors without any light emerging. It is suggested that it might be possible to permit a somewhat higher illumination (say up to 0.002 ft. c., which is still only about one-tenth of full moonlight) on such spots as safety islands, traffic circles and pedestrian crossings.

The most immediately practicable of Mr. Dow's suggestions would appear to be the whitening of curbs and trunks of trees on sidewalks, safety islands, etc., and the urging of all citizens, when on the streets during a black-out, to wear a large white object—a white shirt with coat and vest removed would serve excellently.

Motorists Pay More Than Half of New York's State Expenditures

The Annual Report of the Comptroller of the State of New York for the year ending June 30, 1942, was published only one month later—an unusual and most praiseworthy feature. Also praiseworthy is the fact that, while two years ago there was a deficit of $30,031,354, this had been changed to a surplus of $7,029,257 a year later, and this was increased by $47,098,163 during the last fiscal year.

Fine! But who paid that surplus? Last year motorists paid $61,652,822 for fuel taxes and $37,115,900 for vehicle taxes; a total of $98,768,722 (aside from nearly $22,000,000 distributed to localities); while during the year the State spent $15,812,935 for construction, maintenance and repair of State highways and bridges. Thus the motorists not only contributed all of the surplus increase, but also $35,857,624 toward the other expenditures of the State.

Stated another way, they contributed 51.4% of the total expenditures for all State purposes.

Bottlenecks Eliminated on a Dangerous Piece of Road at Yuma, Arizona

By JOS. C. COYLE

Hazard of a crooked 18-foot pavement and a narrow bridge removed by straightening and widening the pavement and extending bridge roadway across sidewalk strips.

FEW sections of highway have more hazards packed into 1.4 miles than did a portion of 8th street in Yuma, Arizona, before it was widened recently by the state highway department at a total cost of about $10,000. A main artery for traffic between Yuma and the farming district in Yuma Valley, it had long been inadequate to carry the constant stream of automobiles and the heavy trucks and trailers shuttling back and forth between the packing sheds and valley farms, and there had been numerous accidents, some of them fatal.

Where the road drops down a long slope off the Yuma Mesa to the valley, soft sand shoulders made it hazardous to turn off the pavement, yet traffic invariably moved fast, although the 18-foot pavement was not wide enough for safety with the fleets of large trucking units moving over it. At the foot of the hill the situation was complicated further by a narrow bridge over the East Main canal which was used by pedestrians as well as by vehicles. In places the old pavement was far from straight. Improvement was accomplished by adding a 6-foot widening strip on one side or the other, or in some places 3 ft. on each side, whichever gave the straightest pavement.

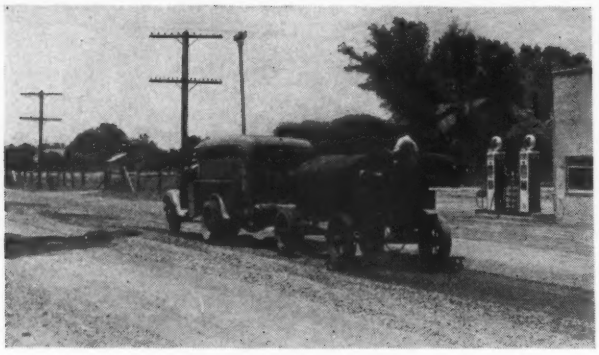
On the highland, excavation for the base course was carried to a depth of 6 in., using a Galion road maintainer. In the valley section the heavy adobe soil was first loosened with the scarifier attachment on the maintainer and then removed with a 6-yard LeTourneau Carryall to a depth of 12 inches to make room for 6 inches of sand beneath the rock base. About 3,500 cubic yards of this waste was used to fill depressions directly north of the highway which had previously collected storm water, and to elevate the approaches on adjacent county roads. In places, hand work supplemented that of the machines in finishing the excavation. The excavated material being insufficient to extend the shoulders enough for safety at certain points, about 4,450 cu. yds. of dirt was moved from borrow pits beside the mesa section of the road, using ithe Carryall.

Covering first pass of oil with Galion maintainer.

Dumping fine mineral aggregate in windrow. Coarse aggregate at the right.

To obtain sand for the sub-base in the valley section, a loading trap was built adjacent to the mesa section so that the tractor and Carryall, which was equipped with a power-controlled dumping mechanism, could move across it and release the load into a hopper, which fed onto a specially constructed belt loader, powered by a Model A Ford motor. This carried the material onto trucks at the rate of about a yard per minute. This loader, which was built in the state highway shops at Phoenix, is easily moved behind a truck from job to job. The 16-inch belt is 40 feet long on centers, is mounted on an 8-inch channel frame, and moves on two rubber tired wheels. It has a trailer hitch at the front end.

Previous road construction in the valley had proved the sand cushion to be efficient in preventing the clay soil from mixing with the base rock during wet seasons and it is more economical than using all rock. From two to four 4-yard Chevrolet dump trucks were



Distributor at work.

used in hauling rock from the Yuma County plant in the suburbs of the city, the average haul being about 1½ miles. The rock base was leveled off with the Galion grader, wet down with a 1200-gallon Chevrolet tank truck, and then compacted with a 5-ton Littleford roller pulled behind a truck.

Two section and one quarter-section survey monuments, previously located in the roadway by land office surveyors, were supplied with covers in the course of construction, making them easily accessible for use by surveyors. These covers were placed on 6-inch rings of concrete. The cast iron frame of each weighs 160 pounds and the cover 36 pounds.

For the oil cake surface, 1-inch maximum rock in two sizes from different bunkers was hauled from the plant and dumped in a double windrow, which was then bladed into one row and mixed, making a total of about 5½ cubic feet of mineral aggregate per lineal foot of windrow. After the windrow had been opened with the Galion, 4% of S.C. 4 road oil was applied by a Standard Steel Works distributor, pulled behind a highway truck. Two passes of the distributor and maintainer were necessary to apply the oil. The material was then turned four times and placed on the old surface with a No. 11 Caterpillar maintainer, after a tack coat of 0.10 gallon per square yard of S.C.2 road oil had been sprayed on the old pavement and the new strips. Traffic was then turned onto the road and the surface was compacted with the Littleford roller. On the old asphalt, the compacted oil cake is a minimum of 1½ inches thick at the crown, thickening to 2½ inches at the edge of the old pavement and on the new construction.

Class A emulsified asphalt for the seal coat was applied with the same distributor, at the rate of 0.5 gallon per square yard; 22 pounds per square yard of chat, wet down at the plant, was applied with a Buckeye spreader box on the rear of a truck backing up over the sprayed strips. Emulsion was delivered in tank trucks by the Arizona Refining Company of Phoenix. During construction traffic continued over the road, but was slowed down and confined to one side of the roadway.

The roadway on the bridge was only about 16 feet wide, with a 3 foot pedestrian walkway at each side, making a dangerous bottleneck crossing. This was eliminated by replacing the pedestrian strips with roadway and pouring concrete curbs 8 inches wide and 11 inches high along the base of the handrails. This gives 22 feet width for vehicles. A pedestrian walk 4 feet wide will be suspended as a cantilever from the curb and hand rail on the north side of the bridge. There was formerly no railing between the pedestrian walks and the roadway.

C. C. Huskison is resident engineer at Yuma for the highway department. Guy W. Cates was foreman in charge of the widening job.

Maintenance of Bituminous Macadam Surfaces

(Continued from page 13)

material. Too much rolling will cause crushing of the pea stone cover and should be avoided.

Another type of surface treatment or seal coat with which excellent results have been obtained, calls for the use of 85% asphaltic oil (approximately grade SC-5 of the proposed specifications of the A.A.S.H.O.). A hot application at the rate of not more than 0.25 gallons per square yard covered with ¾-in. pea stone produces a highly non-skid surface of extreme durability. As with all surface treatments, poor results may be expected if the work is done during rainy weather unless an anti-stripping compound is used.

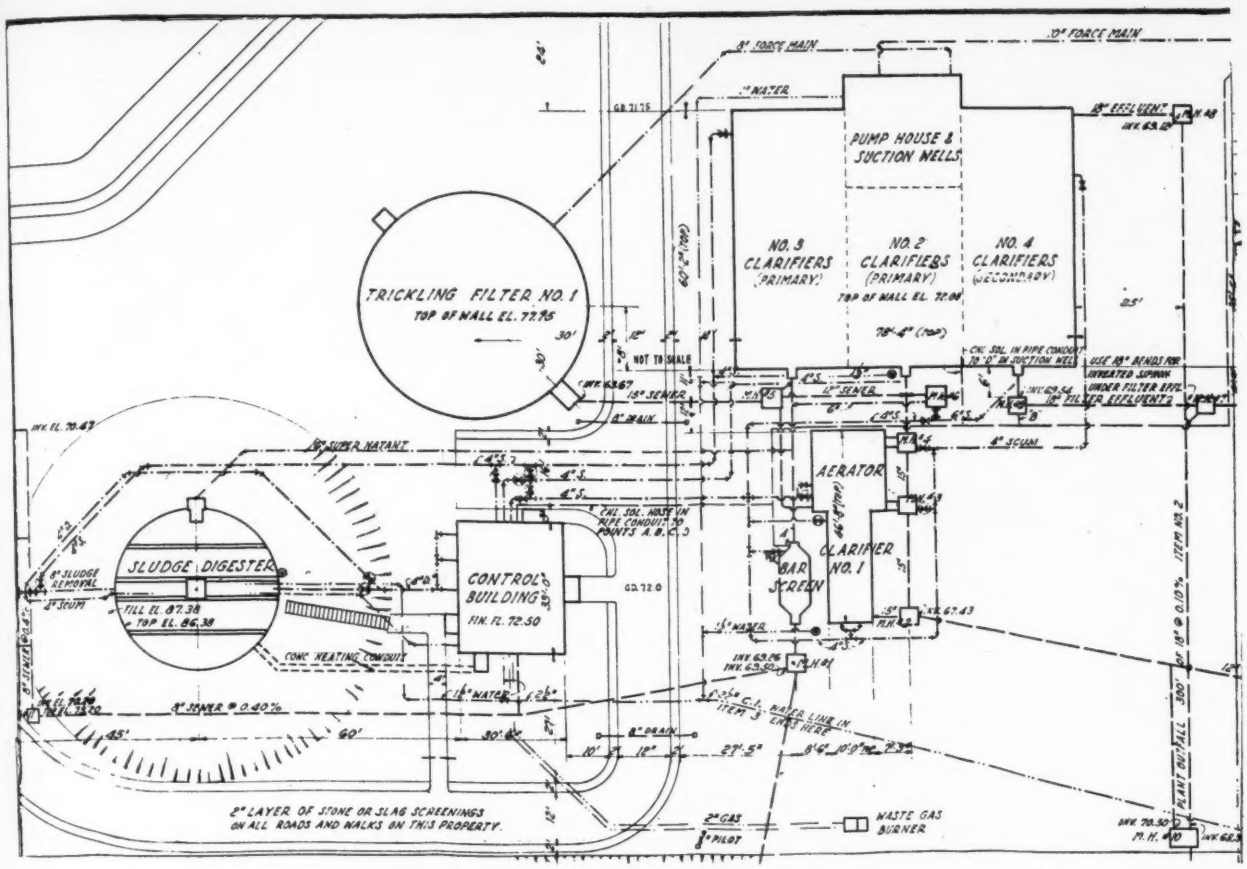
There are a number of pretreatment anti-stripping compounds on the market, for use in connection with patching or surface treatment work, which have certain merits. Most of these compounds work very well in wet weather and are, therefore, very useful in patching a bituminous macadam surface in the spring. In making surface treatments, because of the close adhesion of the asphalt and aggregate, less stone is lost through the action of traffic, and the amount of stone used may be reduced. Also, in case of a rainstorm occurring during the operation, the stone will still adhere to the asphalt.

The cost of a surface treatment to an asphalt macadam road varies not only with the amount and type of cover used, but also with the locality, which greatly affects the cost of materials. A study of surface treatments made during the last few years, however, indicates an average cost of about $1,800 per mile of 30-foot road, which figures about 8c per square yard.

I would like to stress the importance of retaining a well-trained experienced crew of skilled laborers on maintenance work. The value of experienced labor is well illustrated in the single item of "patching." The knowledge of the correct grading of aggregate to use in a particular patch, and of just how much material to use to attain a smooth surface with an even grade, the correct amount of compaction, and in a penetration patch just the right amount of bitumen to fill completely the interstices without creating fat spots, is acquired only through years of experience. The retention of such a force in view of the present war effort is likely to become extremely difficult, but insofar as possible in the interest of low maintenance costs, key men thoroughly familiar with the intimate details of maintenance work should be retained.

This article is based on a paper presented before the Highway Officials of the North Atlantic States.

This narrow bridge created a dangerous condition.



Layout of the Tifton, Georgia, sewage treatment plant.

Operation and Maintenance of the Tifton, Georgia, Sewage Plant

BY D. H. HURST,
City Engineer, Tifton, Ga.

How this plant is operated and how it is operating in its third year—"smoothly with increased efficiency and economy."

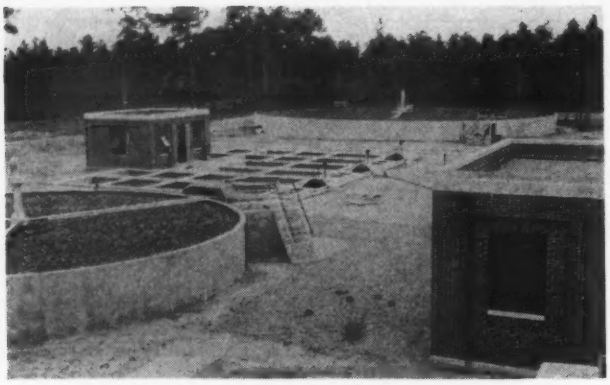
THE Tifton sewage plant was constructed in the year of 1939, and was put into operation in January, 1940. In this, the third year of operation, the functioning of the treatment has been normal and effective; operation has continued smoothly with increased efficiency and economy. The boundary waters have been kept free from pollution to the satisfaction of the State Department of Health and the neighboring communities. The treatment consists of primary settling, trickling filter, secondary settling, and separate sludge digestion. (For description of the plant, see PUBLIC WORKS for August, 1941.)

Tanks and Filters.—The settling tanks are equipped with Jeffrey sludge collectors. All chains are adjusted often enough to keep sludge collectors from jumping and causing excessive wear on chains and sprockets. When tanks are unwatered, walks are washed down, all metal parts are cleaned with a steel brush and coated with oil that has been drained from all parts of the plant when changing oil.

Sewage distributors for trickling filters are of the American Well Works motor driven type. Collector rings are cleaned with gas and sandpaper every four to six months. Little adjustment is required for this type of sewage distributor, grease being the only maintenance cost thus far.

Pumps.—The plant is equipped with five Yeomans Brothers vertical-type sewage pumps. All bearings are washed with kerosene often enough to keep them free from sludge. All pumps are checked for alinement every week or ten days. Packing has been replaced once since beginning of operation; have had one bearing trouble. All bearings are greased at regular intervals.

The sludge pumps are of the Ralph B. Carter plunger type. These pumps require very little adjustment. Packing has been replaced once since beginning of operation. All packing is of the U. S. Rubber Company "matchless" type packing. Sludge is pumped two or three times every twenty-four hours. Some plug-



View of part of Tifton plant, from top of digester. Control building at right. Pump house at left center. Trickling filter No. 2 in background.

ging of lines has been experienced, which trouble was overcome by pumping scum at the beginning and washing out the scum trough with enough sewage to get the scum far enough into the sludge line so that, when beginning to pump sludge, scum would be pushed on to the digester and not left in the line to begin coagulation.

Digester Trouble.—Digester foaming has been experienced in winter months. At first this was thought to be due to an overload from the Armour Packing Company plant, and this no doubt was a contributing factor. However, the main trouble was due to the fact that the outfall sewer from the city to the plant ran through a lagoon which contained one to two feet in depth of waste acid and sand from a nearby fertilizer plant. Infiltration into the pipe line carried enough of this acid to the plant to prevent a normal pH being maintained in the digester. This pipe was replaced with new clay pipe and the joints filled with GK compound. This and other minor adjustments have helped to overcome digester foaming.

Laboratory Data for 1941, Based on Average Flow of 0.675 M.G.D.

	Suspended Solids	*Dissolved Solids*	*5-day B.O.D.*
Influent, City sanitary sewage....	240 p.p.m.	440 p.p.m.	175 p.p.m.
Influent, Armour Packing House waste	486 p.p.m.	2300 p.p.m.	890 p.p.m.
Plant effluent.....	19 p.p.m.	1300 p.p.m.	20 p.p.m.
Relative stability—10 days			

New London, Ohio, Sewer System

The small community of New London, Ohio, recently completed a sewer system, and a treatment plant with a capacity of 135,000 gpd, including an Imhoff tank and trickling filters, at a cost of $180,000. This is a WPA project, the second largest small community project in the 18 counties in Northwestern Ohio. Started in August 1940, the project was delayed by three unforeseen factors. One was the shortage of man power in the skilled categories; another was that the progress of the backhoe in excavating the trenches for the sewer system was slowed by unusual quicksand conditions, with sand pockets and underground springs; and the third was delay in delivery of certain expected and needed materials and supplies as the result of priorities. In view of these obstacles, the schedule has been adhered to surprisingly well.

A thickly wooded area in the extreme northwest corner of the village limits was selected as the site for the treatment plant. Along with the clearing and grubbing of a 2½-acre section, one of the earliest tasks confronting the WPA workers was the construction of a 14-ft. span masonry bridge over Shellinger Creek, which was necessary to make the plant site accessible both by foot and by truck. To provide water for concreting, it was necessary to lay a two-inch pipe line from the nearest main of the municipal water system 1,200 feet to the plant site.

In all, there was installed 6,500 feet of 6″ vitrified pipe, 21,078 feet of 8″ pipe, 7,534 feet of 10″ pipe, 6,872 feet of 12″ pipe and 2,482 feet of 15″ pipe; also 145 manholes, 684 feet of 8″ to 15″ channel pipe and 112 feet of 36″ corrugated iron pipe. The average depth of trenches was 7½ feet. More than 46,700 cubic yards of sewer trench has been dug by the WPA workers, approximately half by hand and half by machine. About half the backfill was made by hand and the rest with a power grader.

An unsuccessful attempt was made to jack the 36″ pipe under the Akron, Canton and Youngstown railroad tracks. When quicksand was encountered it was decided, after a consultation of railroad, village and WPA officials, to lay it in an open cut. It was necessary to open the trench on Sunday during an 18-hour period between 3 a.m. and 9 p.m. when no trains were scheduled. Railroad crews provided and attached the necessary floodlights and handled all track material, leaving WPA workers free for other tasks. The railroad also promised to assume the responsibility in case of delays to their train schedule, but none developed.

For the entire sewer system WPA has allowed $89,080 for labor and $2,616 for non-labor. The sponsor is providing $12,222. For materials, equipment and supplies the village has provided $33,730.

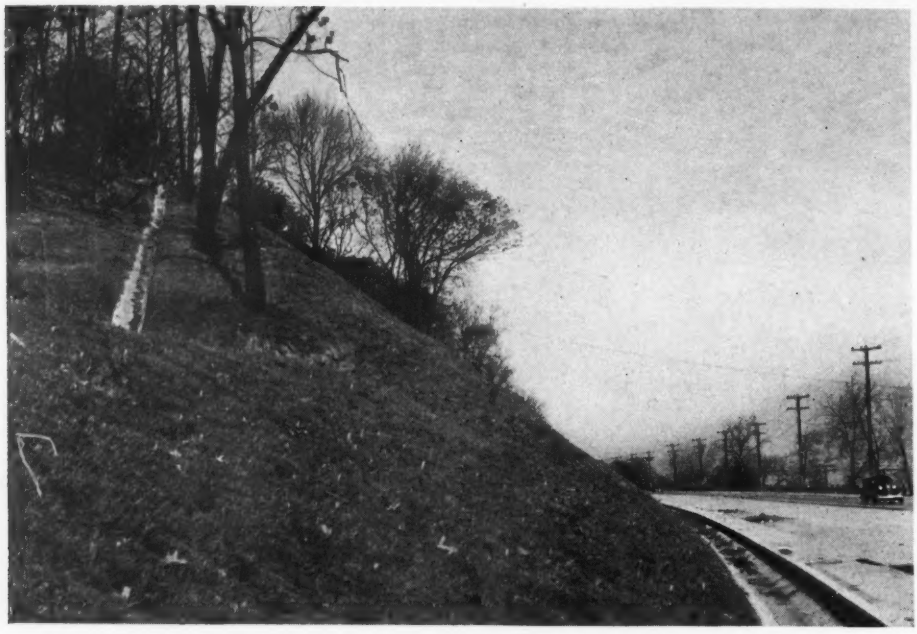
The sewage treatment plant has cost the government $29,078 and the village $15,108—a total of $44,186, if estimates are approximated. Two rotary distributors for the trickling filters, a dosing siphon, three pumping units, 20 tons of pipe, fittings and miscellaneous steel were among the materials, supplies and equipment provided by the sponsor. The WPA provided crushed stone for filters, underdrain blocks, sand, cement, lumber and tools.

The village has been represented on this project by Mayor C. A. Blackman and J. M. Nelson, village clerk. WPA is represented by Steve Robinson, who is project superintendent.

Time Clocks Check Refuse Collection

Five time clocks were installed at Richmond, Virginia's refuse dumps last year, according to Director of Public Works G. M. Bowers in his annual report on the activities of his department. The dates and times of arrival of loads of refuse are recorded by the clocks on cards furnished each truck driver. The cards also serve as a record of gas and oil consumption, miles traveled, and total number of loads delivered to the dumps by each truck.

Twice weekly collection of garbage was established on a year-round basis on October 15 last, according to Mr. Bowers. The unit cost of collection of 7,979 tons of garbage for 1941 was $5.71 per ton, while the unit cost of collection of 458,085 cubic yards of rubbish and ashes was $.38 per cu. yd. Disposal continues to be a problem, it is reported.—*Am. Public Works Ass'n "News Letter."*



General view showing ditch lining and the steep slope of the bluffs. Note the wide paved ditch behind the sidewalk.

Unusual Treatment of Highway Slopes

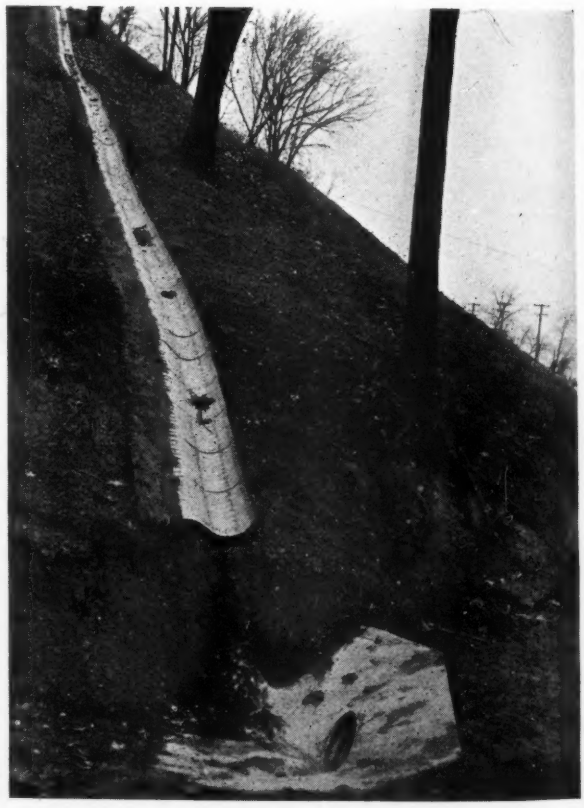
Excavation slopes ran as high as 99 feet. This article describes how they were protected from erosion.

IN MODERNIZING part of the road from Peoria, Ill., to Chillicothe, O., widening was made difficult by the presence of a railroad on one side and high bluff slopes on the other. This necessitated cutting back into the slopes, giving cuts extending up as high as 99 ft. above the highway. The soil here was a fine sand covered with a mantle of clay interspersed with a gravel and sand conglomerate; which would not stand at a slope steeper than 1¼ to 1, and not at this unless protected from erosion.

All cut slopes were sodded, and a ditch run along the top of the slope to intercept the surface run-off. In this work two unusual methods were employed. In the place of an open intercepting earth ditch on one of the slopes, a corrugated metal ditch liner was used. The liner was rolled in a partial S shape and furnished in 8-foot lengths which were laid in a shallow ditch, the back side being imbedded in the bank and sodded over to prevent erosion. After laying and fitting to the contour of the hill slope, it was bolted together, thus providing an interceptor which might be compared to an eaves trough. This also drained into a corrugated metal pipe spillway, as did the open intercepting ditches. The installation was made as an experiment to determine whether such a method of slope protection would be worth the extra cost in cutting down the failures of open earth ditches due to excessive erosion.

The final construction item in completing this section of the highway was the sodding of all cut slopes. As mentioned before, the material in these cuts was

(Continued on page 43)



S-shaped intercepting ditch lining of corrugated metal, provided in 8-foot lengths bolted together. It discharged into a pipe spillway to a catch basin in the ditch line.

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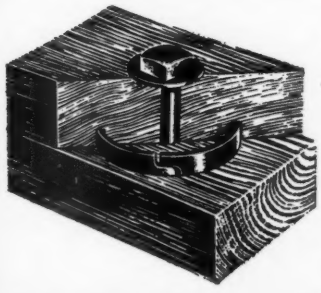

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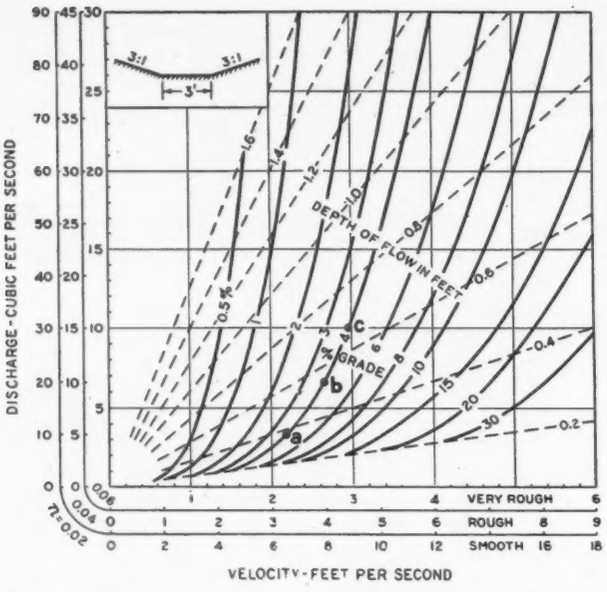

Figure 1.—Relations between grade, depth, discharge, and velocity for a channel 3 feet wide at the bottom and having 3:1 side slopes, for various linings.

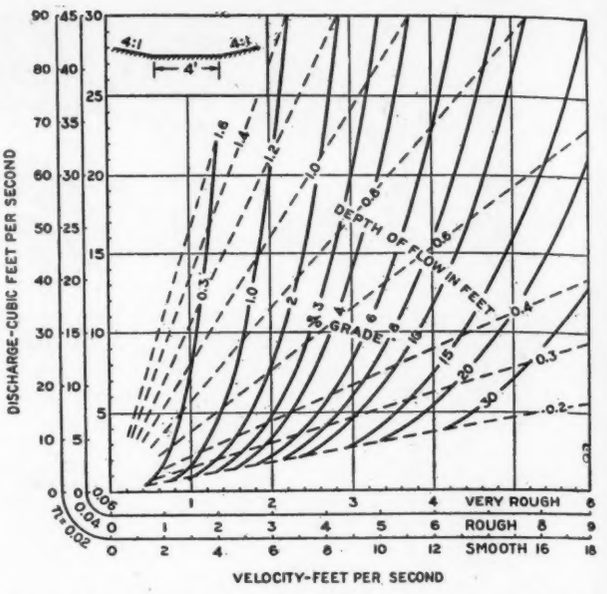

Figure 2.—Relations between grade, depth, discharge, and velocity for a channel 4 feet wide at the bottom and having 4:1 side slopes, for various linings.

The Design of Roadside Drainage Channels*

By CARL F. IZZARD
Associate Highway Engineer, Public Roads Administration

Consideration of erosion control, adequate capacity for normal peak rates of runoff, landscaping, efficient maintenance, ultimate economy, and traffic safety; limited to sections of the country where sod can be established readily.

THE primary purpose of the roadside drainage channel is to provide for efficient removal of surface runoff from the roadway so that traffic can move safely and cars can park clear of the paved roadway in rainy weather when necessary. The channel, therefore, should have adequate capacity to carry the normal peak rate of runoff without overflowing onto the road shoulders. For ultimate economy, the channel should retain this capacity during the life of the road without excessive maintenance costs; this means that the channel should not erode or silt up. In the snow belt, the channel may be designed for snow storage. Since safety is of paramount importance in highway design, the drainage channel should have gently sloping sides and a slightly rounded bottom so that a vehicle forced off the roadway can run down into the channel without overturning. In hilly or mountainous country, practical considerations of economy in first cost will limit the extent to which this ideal cross section may be attained. Prevailing standards of right-of-way width should not be permitted to restrict the width of channel necessary for hydraulic capacity or traffic safety.

The modern highway cross sections in use in most of the State highway departments are in accord with these design principles in varying degrees. The emphasis on traffic safety together with the increasing appreciation of good landscape design has resulted in widespread acceptance of the wide, shallow roadside drainage channel in place of the deep, narrow ditch carried over from railroad design. The practice of seeding or otherwise artificially establishing sod on shoulders, slopes, and drainage channels where feasible has developed as the necessity for controlling erosion became apparent. The principal object of this study is to present a simple method of determining in advance of construction the portions of drainage channels that are likely to erode unless treatment other than ordinary seeding is provided.

Erosion Hazard in Drainage Channels Determined

Control of erosion is fundamentally a matter of controlling the velocity of surface flow or of treating the material so that it will withstand the velocity likely to occur.

The author has prepared diagrams for estimating velocity of flow in three typical cross-sections of channel, with linings that are smooth, rough or very rough; represented by values of n (in Manning's formula) of 0.02, 0.04 and 0.06 respectively; and at grades from 0.3% to 30%; and depths of flow from 0.4 ft. to 1.6 ft. These diagrams are shown herewith. Smoothly

*Condensed from a paper before the Highway Research Board and printed by the Public Roads Administration in "Public Roads".

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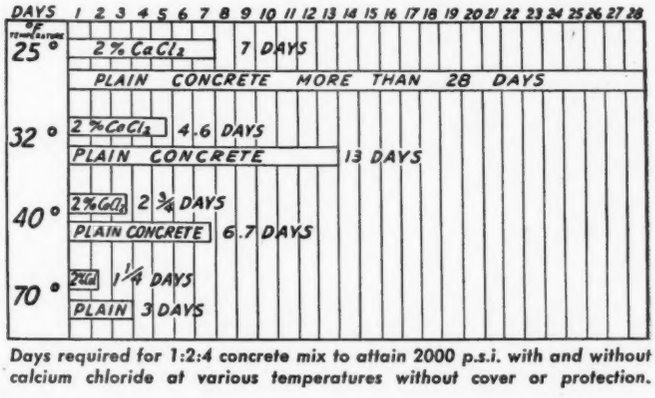
Bulletin No. 28, titled "Early Strength Concrete," gives all the data from Bureau of Standards reports, and includes numerous examples of field experience on large and small jobs. Every man who places concrete should have this important manual. Write for it today.



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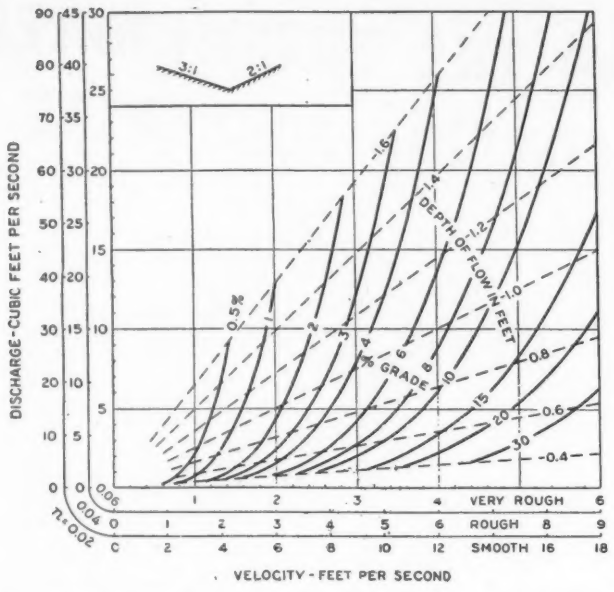


Figure 3.—Relations between grade, depth, discharge, and velocity for a V-shaped channel having 3:1 and 2:1 side slopes, for various linings.

graded earth, rough concrete and smooth rubble are classed as "smooth"; jagged rock, rough rubble, and well-maintained grass with a depth of flow over 6" are classified as "rough"; and such grass with a depth of flow under 6", and heavy grass, are classed as "very rough." In general, use the roughest condition likely to exist for estimating capacity, and the smoothest condition for estimating velocity.

For example, if the channel is 3 ft. wide at the bottom, with 3:1 side slopes and 4% grade, and if the peak of runoff is estimated to be 10 cfs, the velocity in an earth channel is found to be 6.8 fps, which is excessive for earth, so sodding is necessary. This, it appears from the diagram, will cut down the velocity to 4 fps, which is allowable for good sod. (See table 1.) The diagram also shows that the depth of flow will be about 0.55 ft. If the grass in the channel is allowed to grow rank the velocity will be reduced to about 3 fps, and the depth increased to 0.67 ft. A freeboard of at least 0.3 ft. should be provided above the maximum depth of flow to allow for silting, for wave action, and for a factor of safety against a too-low estimate of peak runoff.

Table 1.—Allowable Velocities in Various Channels

Type of lining	*Allowable velocity Feet per second*
Well-established grass on any good soil: [1]	
Bermuda grass	6
Bluegrass	5
Smooth brome grass	5
Western wheat grass	4
Buffalo grass	4
Sudan grass (annual, temporary cover)	3
Common lespedeza (annual, reseeding)	3
Lespedeza sericea	3
Earth without vegetation: [2]	
Fine sand or silt, noncolloidal	1-2
Ordinary firm loam	2-3
Stiff clay, very colloidal	4
Clay and gravel	4
Coarse gravel	4
Shale	5

[1] Data from Roadside Development Report, Part II, Appendix IV, April 1940.

[2] Data adapted from recommendations of Special Committee on Irrigation Research, American Society of Civil Engineers 1926.

In channels with comparatively flat side slopes the discharge capacity increases rapidly with small increases in depth, and consequently the allowance of 0.3 foot freeboard is usually adequate. In the example, the discharge capacity at a depth of 1.0 foot is more than double that at a depth of 0.67 foot. The resulting velocity is about 5.5 feet per second on the "rough scale" which is above the recommended limit for bluegrass sod, but since this limit is conservative, no appreciable damage need be anticipated by a runoff double that for which the channel was designed. Silting in the bottom of the channel, while reducing the depth of flow, will reduce both the cross-sectional area and the discharge capacity only a small amount. For the same reason the rounding of the bottom of the channel usually shown on typical cross sections does not significantly affect the discharge capacity computed for a strictly trapezoidal section.

Several Means of Increasing Capacity

In any channel with fixed side slopes the discharge capacity may be increased by increasing (1) grade, (2) bottom width, (3) depth, or through decreasing resistance to flow by providing a smoother lining. Increasing the grade is frequently impractical. Increasing the bottom width has the least effect on velocity and is therefore desirable where velocity is close to the limit. On the other hand, increasing the depth, while increasing velocity slightly more than that with increased bottom width, is the simplest procedure and also requires less over-all width. The latter consideration is important where right-of-way is restricted or expensive. Smoothing of the channel lining provides increased capacity without increased width (or may even permit a reduction of width) but, since this must generally be accomplished by some kind of paving, the cost may become excessive.

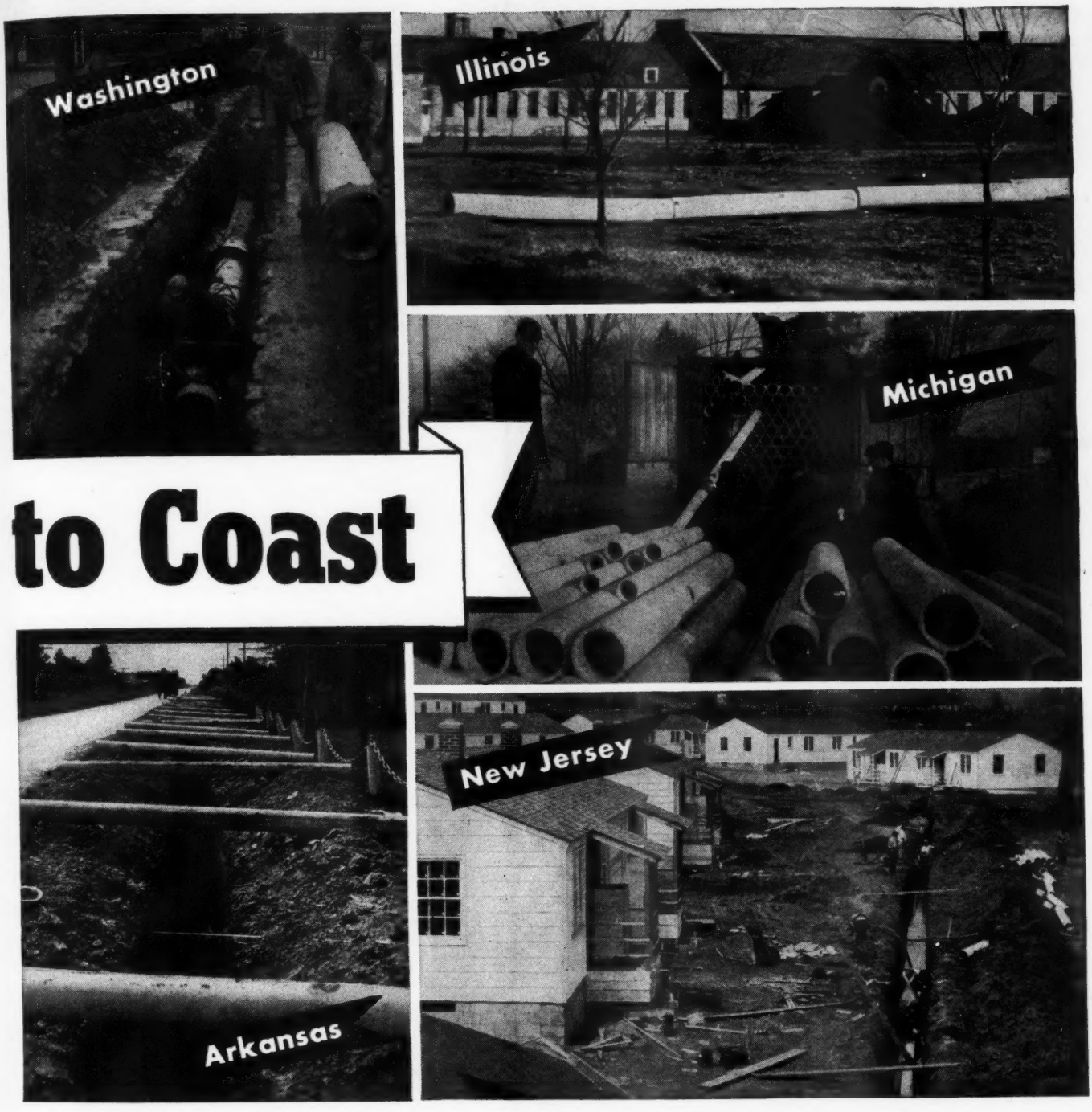
The effect of channel cross-section on depth of flow, velocity, and required width of channel is shown in Table 2, based on Figs. 1, 2 and 3. The difference between the "discharge flowing full" and the assumed 10 cfs is the reserve capacity afforded by the 0.3 ft. freeboard.

Table 2.—Examples of Effect of Channel Shape on Capacity [1]

	3-foot bottom 3:1 slopes	*4-foot bottom 4:1 slopes*	*V-bottom 3:1 and 2:1 slopes*
Depth of flow, feet	0.95	0.80	1.45
Depth plus 0.3 foot freeboard, feet	1.25	1.10	1.75
Velocity, feet per second	1.8	1.6	1.9
Width (including freeboard) feet	10.5	12.8	8.8
Discharge flowing full. cubic feet per second	17	18	16

[1] Taken from figures 1, 2 and 3 with discharge of 10 cubic feet per second flowing in sodded channels on a 1-percent grade ($n = 0.06$).

Beyond 2% grade, as this increases the velocity approaches the safe limit for a sodded channel. It may be kept low by increasing bottom width or flattening side slopes. If right-of-way has not sufficient width for this, the channel may be paved. Smooth paving permits material reduction in size of channel; but rough paving may be desirable on steep grades to prevent velocities that can not be controlled. High velocities must in some way be checked at the outlet unless the channel discharges into a body of water of appreciable depth. Velocity may be checked by a wide apron with projections or baffle walls on the surface or by a low sill at the end, creating a stilling pool. Current research on this problem, which exists at culvert outlets also, should provide more definite principles for the design of energy-dissipating structures.



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For traffic safety, side slopes of a paved channel should be as flat as practicable in locations where vehicles might be forced to drive down into the channel. In other locations, as at the top of a cut slope, or the toe of a fill slope protected by guard rail, economy dictates the use of a more efficient hydraulic section. The most efficient section, a semicircle, is difficult to construct and a semihexagonal section is preferable.

In an ideal cross section in earth, the side slopes should not be steeper than 4:1—the steepest that permits a driver in the outside lane to see the entire length of the slope. A rounded bottom at least 4 ft. wide is desirable in earth, and a depth below the edge of the shoulder of at least 1 ft. in dry regions to 1½ ft. in wet—greater of course where runoff requires it. If this cross section requires excessive amount of excavation, the bottom may be narrowed and back slope steepened to not more than 2:1 and the front slope to 3:1; but this may require closely spaced culverts or auxiliary channels to avoid overflowing during peak runoff.

The flat slopes of this ideal cross section permit a vehicle to cross at any angle with a reasonable chance of remaining upright, can be mowed mechanically, provide space for snow storage, lessen chances of snow drifts, easily merge into the landscape, and relieve drivers of fear of accident if they should have to drive off the pavement.

In solid rock cuts, the backslope will necessarily be very steep, approaching the vertical in the extreme case. In such instances the drainage channel may have a narrow, rounded, V-shaped cross section just large enough to carry the peak runoff without overflowing on the shoulder. Another design having considerable merit requires paving the entire shoulder and providing for drainage in a monolithic curb and gutter with closely spaced catch basins emptying accumulated drainage into cross culverts or into storm sewers. Such a design balances the cost of additional excavation in a wider cut against the cost of more expensive drainage facilities and at the same time affords a maximum of all-weather traffic safety. It is difficult to maintain narrow sodded shoulders between a paved gutter and the paved roadway; in such cases the shoulder should be stabilized and surface-treated.

In a rock channel, velocity of flow is not a factor, and economy is the chief consideration. Paving the channel to give a smooth surface increases velocity and so permits reduction of cross section and of cost of excavation, in some cases this reduction of cost more than equaling that of paving. Smooth lining also facilitates removal by the water of accumulations of rock spalls, sand, etc.

Instead of making the channel wide and flat to reduce velocity, this may be accomplished by use of ditch checks and drop structures. By building steps of concrete or other suitable material at intervals along the channel, the grades between such drops can be kept at that not causing erosion at peak discharge. The channel discharges into this structure through a weir notch, which may have the same shape as the channel but is more frequently a constriction in it. An apron with wing walls must be provided below the drop. Safety considerations limit the drop in roadside channels to about 6 in. Each such drop will cost $5 to $10 or more, and in most cases it would be cheaper to construct a continuous paved gutter 3 to 5 ft. wide or a sodded gutter 9 ft. wide.

Drop structures in channels parallel and close to the roadway are a traffic hazard, interfere with mowing and are unsightly. In some soils they are difficult to maintain because the soil is washed out below and around the structure. But they are useful in channels inaccessible to vehicles, as where a channel drops off suddenly into a creek.

The rate of discharge is the fundamental criterion in designing a channel. This may be calculated by the Burkli-Ziegler formula or by the rational method. But the simplest method, and probably as reliable as any, is the use of runoff curves of the type published by the Highway Research Board in April 1940, in Appendix IV of the Roadside Development Report, Part II. By selecting a curve representing the topographic, soil, vegetal cover, and surface storage characteristics of the drainage area, the peak rate of discharge may be read directly in cubic feet per second from the size of the area in acres.

Sodding Channels

The kind of grass selected for seeding or sodding a channel should preferably be a short-bladed variety with a deep root system forming a dense turf and not a bunch grass around which the water will wash, or a stiff-stemmed grass which will not bend flat under the pressure of the current. The efficacy of sod for controlling erosion results largely from the "shingling" or "thatching" action which protects the soil from the rapidly flowing water in the stream. A favorable circumstance is the fact that in most regions the highest intensity rains, which cause the most erosion damage, normally occur during the summer months and not when the grasses are dormant. Experiments with bermuda grass, however, indicate that its resistance to erosion is practically as good when the grass is dormant as when it is green.

When seeding can be done at the right season of the year to establish a reasonably good turf in a short period of time, channels from very small drainage areas may be seeded instead of sodded, taking the chance that a damaging rain will not occur during that period. Any necessary reseeding will probably still involve less total cost than an initial installation of sod. Mulching of the seeded areas, now rather common practice, greatly decreases the chances of damage by intense rains. Local circumstances and individual judgment will determine the extent to which chances may be taken on seeding in drainage channels.

In some regions grass is normally established by sprigging or planting stolons and roots, relying on the natural spreading habit of the particular species to establish complete cover in a short period of time. In such regions the remarks about seeding will apply with equal significance to these other inexpensive methods of establishing grass.

A compromise solution is to sod only the bottom of the channel (assuming the bottom to be rounded) on the chance that a rate of runoff sufficient to rise above the sodded area will not occur until grass has become established by other, cheaper methods on the rest of the channel. To play safe, however, sod should be placed to an elevation slightly above the depth of the peak discharge for which the channel is designed (this procedure is recommended where sod is plentiful and relatively inexpensive).

Vegetated channels can function satisfactorily only if they are adequately maintained. Channels should be mowed regularly to avoid excessive restriction to flow and to keep down weeds. Bare spots should be repaired by sodding immediately upon discovery, as small breaks in the sod enlarge rapidly when subjected to heavy flows. Silting of the channel is a troublesome problem that can be permanently solved

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 65-67

only by tracing the silt back to its source and eliminating erosion at that point. Since silt is deposited only when the carrying capacity of the stream is reduced by checking the velocity, channels should be designed, insofar as practical, so that the gradient is always increased, and never flattened, in the direction of flow.

Electrical Drainage of Fine Soils

To overcome the difficulty encountered in excavating fine-grained soils such as clay, loess, or silt, whose high capillarity may render the usual methods of drainage ineffective, large-scale experiments with an electro-osmotic process have been carried out by the German State Railway Directorate *(Reichsbahndirektion)* at Hanover. The process consists in inducing osmosis in the soil by passing an electric current through a series of electrodes, thereby causing the water in fine-grained soils to move from one electrode to another. For large-scale drainage, the electrodes must be arranged and designed, and the current ratio correctly chosen, to suit local conditions. An account is given of the successful drainage of a cutting, 25 ft. deep and 115 ft. wide, in fine silty clay. During excavation the soil became so plastic that realignment was seriously considered. The electrical drainage of a 330-ft. length was undertaken experimentally. Twenty 4-in. well pipes, serving as electrodes, were installed to a depth of 25 ft. Pumping produced a negligible flow of water until the electrical circuit was closed, when the total flow rapidly rose to over 88 cu. ft. per hour. After a few days the soil was capable of supporting mechanical excavators, and the experimental section was completed several weeks before the remainder of the cutting. The completed portions were at once covered with sand or topsoil to prevent surface water from reaching the capillary material. In the experimental drainage of an embankment where spreading had occurred, it was found that, although the flow of water towards the electrodes was intercepted by pockets of gravel, the water content between the electrodes was reduced from the original 23.8 to 25.8 per cent to 14.3 to 17.4 per cent. Since the plastic limit of the fine-grained portion of the embankment lies at about 21 per cent, success will be ensured if constructional precautions are taken to prevent the renewed entry of large amounts of moisture into the embankment (possibly through the central strip). The method may prove of special use in a number of cases where rapid and effective drainage is essential, e.g., in checking incipient landslips and in the treatment of excavations and earthworks. In excavations the expense of sheet-piling may be obviated or greatly reduced. The cost necessarily depends on that of electric power; the power consumption may vary from 4 to 40 kw. per hour per cu. yd. according to the nature of the soil. The applicability of the method should be ascertained by preliminary tests on models and by soil tests, supplemented by detailed information regarding local conditions. — *"Road Abstracts" from "Strasse."*

Emergency Repairs of Gas Pipes

The Brooklyn Union Gas Co., which serves 3,000,000 people of Greater New York City, has trained a defense corps among its employees in methods of handling breaks in mains, including quickly stopping the flow of gas and making emergency repairs. Few low-pressure mains are supplied with valves, and other means must be adopted. They consider the use of a conical shaped plug the most efficient method, especially if the escaping gas is burning. The plug, which fits the pipe snugly, can be attached to one end of a long pole and pushed into the pipe, the man handling the pole wearing asbestos clothing if necessary. But if the flame is very large this may be impracticable, and a cable can be stretched across the bomb crater, the plug being suspended in a cradle from the center of the cable, which is moved (by a man holding each end) until the point of the plug is in the end of the pipe. The large end of the plug is dished out, and a man with a long pole can readily push the plug into the pipe, even if standing at one side out of the tongue of flame.

The use of a gas bag is possible, if the gas is not on fire; if it is blazing, an opening can be made in the pipe some distance back from the break and the bag inserted there. Standpipes through which a bag can be inserted, located at intervals in the pipe system, as valves are located in water mains, permit rapid stopping of the flow of gas.

Another method, practicable for low-pressure mains up to 12", is to pour a heavy grease into the main by means of a service pipe, using a sufficient quantity to plug the pipe. This, however, necessitates digging up the pipe at this point to remove the plug. About 60 lb. of grease, forced in by means of a portable gasoline-powered pump in 4 or 5 minutes, will plug a 6" main.

How Fernandina Prevents Sewer Settlement

Fernandina, Fla., is a coastal city on Amelia Island, at the northeast corner of the state. Unlike most cities along the South Atlantic coast it is 10 to 50 feet above sea level, which, as the island here is only about a mile and quarter wide, gives excellent drainage both east and west. The top soil is supported by yellow loam 10 to 40 feet deep, through which rapid seepage takes place, causing constant settlement and breakage of the drainage lines.

Repairs to these breaks seldom lasted more than two or three months, until a new plan was adopted. After removing the broken line, coarse rock and shell was placed to a depth of 2 feet below the drain and on this a cradle of creosoted timber, and the pipe was laid on this cradle. The drain here is about 12 feet below the surface. Apparently this plan is successful, as the street surface has not yet shown any breaks, which heretofore have appeared when a drain rupture occurred.

The above information is sent us by R. B. Meserve, city manager of Fernandina.

Solving a Green Water Trouble

The Maryland State Department of Health, in its annual report for 1941, tells the following interesting experience:

An investigation was made of a green color which had developed in the open storage reservoir at Havre de Grace. Microscopic studies showed that the color was due to the presence of excessive growths of plankton with *Chlorophyceae,* a green algae, predominating. These growths were apparently stimulated by the high percentage of sunshine during the month of April. The United States Weather Bureau reported that, for the Baltimore area during the month of April, 75 per cent of the available possible sunshine was present. This was the highest percentage reported since 1899.

At our recommendation the reservoir was immedi-

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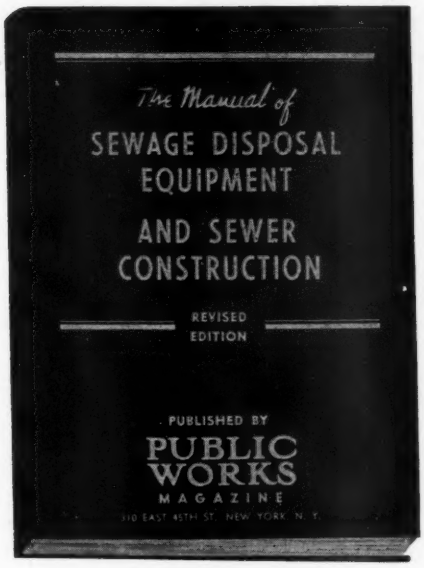

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ately drained and after a thorough cleaning and scrubbing with copper sulphate and hypochlorite, the reservoir was filled with fresh water. Copper sulphate treatment of the water was continued at frequent intervals during the critical period with the result that green water troubles were not encountered again.

WPA Work for the St. Paul Water Department

The Water Department of St. Paul, Minnesota, has co-operated with the Federal Unemployment Relief Program ever since its inception in the late Fall of 1933 and has had one or more Federal Aid projects in operation ever since that time, carrying through CWA, ERA and WPA. A CCC unit of some 250 boys, and wholly paid from Federal funds, was engaged in park and watershed improvements beginning August 1935 and continuing through 1936 and the Spring of 1937.

The work of the various agencies was quite varied and designed to utilize native materials and labor (rather than purchased materials and equipment use) to the greatest possible extent; and although some of the projects approximated "make-work," many worthwhile improvements were made to the water system.

The work of these projects has comprised extensive improvements to watersheds, erosion control at the department's lakes designed to make for eventual increase in their storage capacity, the clearing and transplanting of trees and other improvements to already reforested areas, resulting in placing some 200 additional acres under forest; the shortening, rock paving and other improvement of canals, reclamation of swamp lands, grading and paving of nearly four miles of roads in the lakes region, and the grading, curbing and paving of nearly a mile of road at the McCarron Station; many park improvements, the development of picnic areas now used by thousands of the public yearly (and which enables the public to have closer acquaintance with and appreciation of the nature and extent of the department's works); the erection of a garage addition and several minor structures, installation of a few water mains, an extensive painting program under which all hydrants and all of the steel reservoirs have been painted at least once and the great areas of the filter plant building twice; the filling over of about six miles of conduit, the surveying, mapping and monumenting of the boundaries of many of the department properties, and considerable assistance in such works of rehabilitation as the repair of reservoirs and the construction, not yet completed, of sludge disposal settlement basins in connection with the water softening process. All work of this nature was suspended December 31st; and although Presidential approval has been given for another Water Department WPA project, the actual commencement or long continuance of any such work under present war conditions is very questionable.

These projects have employed up to 3,000 men at one time (at peak periods), all paid from Federal funds and under the direct supervision and administration of the Federal Government and Water Department plans. The department has had no control over the expenditure or accounting of such Federal funds.

While the department has unquestionably gained much by the operation of this program (particularly the more recent WPA projects), it has at the same time been required to make certain contributions therefor, some of which caused the accomplishment of certain improvements which might have been postponed.

The Water Department's contribution of $382,778.99 includes $176,438.11 as value of native materials incorporated in the work at no cost to the department, and that a very great part of the $206,340.88 shown under Water Department Expenditures and Equipment Rentals is comprised of arbitrary rental rates for normally unused department equipment and by wages of department employes who would have been engaged in similar work whether there had been any such projects or not.

Because of work conditions, Federal regulations, indiscriminate assignment of workers whether competent, adapted, fit or not, the almost complete use of hand labor unaided by equipment, the adaptation and use of native materials rather than the purchase of materials especially adapted to the work, and the great turnover and fluctuation in the number of workers (because Water Department projects were used as a reservoir to take up excess workers in slack periods and as a pool to draw from when workers were in demand, the crews ranged from 20-30 men to 3,000 and the changes were often made without warning or advance preparation or planning), the cost of the improvements were very greatly in excess of costs which would have prevailed under normal conditions.

From the 1941 report of the St. Paul Board of Water Commissioners.

Stabilizing Highway Slopes

Many dollars are expended uselessly in highway maintenance in removing, from the bases of slopes in cuts, material eroded from the slopes. Even low cuts, hardly noticeable in passing, may be so numerous as to boost the cost of maintenance surprisingly.

Flattening of slopes alone will not reduce erosion, particularly in friable or highly erodable soils; in fact, increased area of exposed slope may increase erosion if there is no protecting vegetation. Soil which contains no humus is of no value from an erosion-prevention standpoint other than to create a bed wherein seeds will sprout more quickly; such slopes should be covered with topsoil.

The general sequence of operations in blanketing sterile slopes with topsoil is as follows:

1. In designing the project slopes must be made as flat as possible. The steepest slope upon which topsoil can be economically held is 1½:1. However, ease of application and effectiveness of control increase directly as the slope is flattened.

2. Determine area of slope surface and compute quantity of topsoil required to provide a cover of 6 inches minimum thickness.

3. Remove the topsoil layer containing humus from within the excavation limits and stockpile or windrow this soil outside of the slope stakes.

4. Excavate the cut in such manner as to leave a fairly rough surface. Irregularities up to 6 inches from a plane surface are acceptable. Scraper excavation will leave horizontal grooves and ridges which act as terraces to hold the topsoil. Smooth bladed surfaces, especially on a 1½:1 slope will not hold dry or lumpy topsoil, without water or support.

5. Immediately following excavation of each particular slope the topsoil blanket should be applied. Delaying this operation allows loose subsoil to filter down the slope and fill the irregularities which are so valuable in their retention of the topsoil. Pulverizing and

moistening the topsoil aids materially in placing and retaining it on the slope.

6. If seeding is considered necessary it should be done immediately upon completion of the topsoil blanket before rain or heavy dew can form a crust upon which the seed cannot be retained.

If it is impossible to obtain sufficient topsoil in this manner, imported topsoil must be used. If topsoil is not available humus material in the form of straw or manure may be worked into the slope surface.

From an article by H. Dana Bowers, landscape engineer, in California Highways and Public Works.

Sewerage Maintenance Notes from Indianapolis, Ind.

DURING the year 1941, inspections of connections from combined sewers to intercepting sewers were made at intervals of only a few days, so that overflow of sewage to the various streams could be kept at a minimum. A total of 191 stoppages were removed.

The mechanical equipment for cleaning the bar racks at the sewage treatment plant and removing and washing the grit operated very satisfactorily during the year. The putrescible matter in the grit averaged 4.61% in the unwashed and 1.05% in the washed; the maximum for the former being 6.86% in March, and for the latter 1.42% in February, being below 0.85% for four of the 12 months. The washed grit was used as material for fill along a public highway.

The problem of removing grease, oil and other floating material from the four old primary tanks was made less difficult by the construction of a frame supporting a skimming board, which rolls along on top of the division walls of the tanks on steel wheels. These can easily be operated by one man. Automatic skimming by the return flights was out of the question in these tanks because of the irregular shape of the tanks.

The garbage reduction plant treated 30,343 tons of green garbage during the year; from which 1,687,950 lb. of grease were recovered and sold, 2,584 tons of fertilizer and 1,474 tons of feed; producing a revenue of $3.74 per ton of green garbage. The cost of operation averaged $3.44 a ton. The prices received for the by-products increased materially during the year.

Unusual Treatment of Highway Slopes

(Continued from page 30)

primarily a fine sand, which, to stand on a steep slope, had to be protected from erosion. In order to hold the sod successfully on the 1¼:1 slopes until a root system could be developed, a light weight galvanized wire mesh was laid at right angles to the center line of roadway. This was anchored at the top by hooked steel rods 3 to 4 feet in length driven into the clay which overlaid the sand. The sod was placed over the mesh, the strips being laid at right angles to the mesh, tamped and pegged, the stakes extending through the mesh.

The above is from an article by D. J. Deyoe, resident engineer, Illinois Division of Highways, in "The Highway Magazine."

Fundamentals for Designing Low Dams

(Continued from page 16)

that *may* ever occur. The engineer must weigh the local conditions, estimate the damage and loss that would be caused by failure, and consider these in comparison with the cost of providing for such unusual floods. Generally the assumptions should be on the safe side.

c. Flood runoff is influenced by local factors, such as the slope, length, shape, and area of watershed; and its character, as wooded, agricultural, sandy or rocky.

d. A complete investigation should be made of all local information; past big floods should be inquired into; old inhabitants should be consulted. Available records of nearby or similar streams should be checked.

7. *Records of Flood Runoff.* — There are few records of flood runoffs from small areas. In Central New York State, a few years ago, certain small areas appeared to show runoffs of about 2000 cu. ft. per second per sq. mile. Other records are:

Stream	*State*	*Sq. Mi. Drainage Area*	*Cu. Ft. Runoff per Sq. Mi.*	*Date*
Elkhorn Creek	W. Va.	44	1363	June, 1901
Cameron Arroyo	Colo.	7.3	1900	June, 1921
E. Quartermaster Creek	Okla.	41.5	1320	Apr., 1934
Bunton Branch	Tex.	4.1	3370	June, 1936
Olmas Creek	Tex.	26.4	1061	Sept., 1921
Atacosta River	Tex.	21.3	1220	June, 1924
Hull's Gulch	Idaho	5.0	1000	July, 1913
Willow Creek	Ore.	20.0	1800	June, 1903

It will be noted that the records for small drainage areas are very meager. A runoff exceeding 2000 cu. ft. per sq. mile appears possible, but has been recorded in very few cases.

A rainfall rate of 1 inch per hour is practically equivalent to an average fall of 1 cu. ft. per second on each acre of area. Therefore, unless there is snow on the ground which, by melting, adds to the volume, the maximum runoff that theoretically can occur will be 1 cu. ft. per acre for each inch of rainfall per hour, or 640 cu. ft. per second per sq. mile. Therefore, a rainfall rate of 3 ins. per hour, which is exceedingly rare over any extended area, would be required to produce a runoff of 1920 cu. ft. per second from one square mile.

This theoretical maximum runoff is subject to certain modifications which should not, under most cases, affect materially the amount of flow.

8. *Estimating Flood Runoffs.* — a. *Limiting Flood Method.* — When records of maximum floods, in cubic feet per second per square mile, are plotted, a curve is produced, the formula for which is assumed to be $q = C \div \sqrt{M}$, where q is the discharge in cubic feet per second per sq. mile, C is a coefficient that varies with the locality, and M is the area of the drainage basin. A value of C = 6000 defines the upper limit of flood peaks in the eastern United States, being exceeded only rarely. It does not appear that this formula is correct for very small areas, as it gives a runoff of 6000 cu. ft. from a 1-mile area, which is excessive as it represents the total runoff of a storm having a rainfall intensity of 8 ins. per hour.

b. *The Rational Method.*—The rational formula for storm water runoff is $Q = CiA$, in which Q is the peak discharge in cubic feet per second; i is the rainfall rate in inches per hour for a period equal to that required for the flow from the most remote

point in the watershed to reach the dam; A is the area in acres of the drainage basin; and C is the coefficient of runoff. The procedure in computing is as follows: (1) Determine the average velocity of flow in the principal channel from the headwaters to the dam, and increase this by 30% to compensate for the increase due to the flood wave. (2) Convert this into time required for flow from the headwaters to the dam. Ordinarily travel of the water over the ground to a channel, through brush but on fairly steep slopes, will be 0.1 to 0.2 ft. per second. In the smaller streams and channels, velocities will be 3 to 5 ft. per second. (3) Determine the average rainfall intensity for the time so calculated. (4) Select a value for C, which will depend on local conditions and on the flood frequency expectation, as for 50 years or 100 years. (5) Multiply C, i and A together.

A detailed article describing a modified rational method of estimating flood flows appears as Appendix A, *Low Dams,* published by the Superintendent of Documents, Washington, D.C., in which values of C for a 50-year period are given ranging from 0.85 to 0.90; for 25 years from 0.72 to 0.81; and for 10 years from 0.59 to 0.71. It is believed that, since much depends upon local conditions, these high values should be justified before being used.

c. *Example of Use of Rational Method.*—A watershed has an area of 1.35 sq. mi. or 834 acres; it is 2 miles long; the slope averages 37 ft. per 1000; topography is rugged, with steep hills, but entirely wooded. The stream channel is crooked and strewn with boulders. A study of the time of concentration involved both the timing of storm flows occurring in the upper reaches and a check computation of the rates of flow. Time of concentration was determined as approximately 52 minutes. For estimating rainfall rate i, several formulas have been proposed. Two of these are:

Meyers, 100-year expectancy

$$i = 256 \div (t + 25) \quad (1)$$

Talbot, maximum rate of rare rainfall

$$i = 360 \div (t + 30) \quad (2)$$

By the Meyers formula, for $t = 52$ minutes, $i = 3.32$; by the Talbot formula, for $t = 52$, $i = 4.4$ ins. Assuming $i = 4.4$ ins., and $C = .75$ (which is very high for wooded land), $Q = .75 \times 4.4 \times 834 = 2752$ cu. ft. per second, or $2752 \div 1.35 = 2030$ cu. ft. per second per sq. mile.

d. *Comment on Above Example.*—The example just quoted was a specific case in southern New York State. The New York City absolute maximum rainfall is estimated to be 4.35 ins. for 50 minutes, or about 4.25 ins. for 52 minutes. The figure of 4.4 ins. used is therefore safe, especially since the New York 100-year frequency rainfall curve shows only 3.15 inches for 50 minutes and the 50-year curve only 2.8 ins.

The coefficient of runoff must be estimated with all available data at hand. In the 1913 Ohio floods, runoff coefficients on the Miami were 0.76 and on the Scioto 0.59. Metcalf & Eddy, in discussing design of storm sewers, where the same situation exists, advocates $C = 0.371$. Horner assumes $C = 0.50$ for a 60-minute storm, but his work was mainly in a city where there were many paved streets. It is believed that, in most cases, where watersheds are wooded and not too rocky and impervious, a C of 0.60 is sufficiently large to be used with safety.

e. *Empirical Formulas.*—There are a large number of empirical formulas for estimating flood runoff.

Not all of them are reliable for use outside of the areas in which and for which they were developed. They are, however, of value in checking the data obtained by the use of the rational method. Information will be given for each, and the example given in Par. 8-c will be worked out.

(1) The Burkli-Ziegler formula is $Q = Ci\sqrt[4]{SA^3}$. With $C = .75$ (as in Par. 8-c); $i = 4.4$; $S = 37$; and $A = 834$, $Q = .75 \times 4.4\sqrt[4]{37 \times 834^3} = 1260$ c.f.s. or 935 cu. ft. per second per sq. mile.

(2) Kuichling's formula for small watersheds is $Q = 35{,}000 \div (M + 32) + 10$. M is the watershed area in sq. miles, which is 1.35. Then $Q = (35{,}000 \div 33.35) + 10 = 1060$ c.f.s. or about 780 cu. ft. per sq. mi.

(3) The Davis and Wilson formula is based on the inches of rainfall in 24 hours and is therefore more applicable to larger watersheds. It is Q = inches of rainfall in 24 hours x 200 x $M^{\frac{2}{3}}$, where M = drainage area in square miles. Assuming a 12-inch rain in 24 hours: $Q = 12 \times 200 \times 1.35^{\frac{2}{3}} = 2{,}900$, or 2,150 cu. ft. per second per sq. mile.

(4) The Dickens formula is $Q = C\sqrt[4]{M^3}$. This formula uses a special C of 350 for mountainous country and is based on the rainfall that occurs in 24 hours, presumably on a 6-inch rain. This gives $Q = 350 \times \sqrt[4]{2.46} = 350 \times 1.25 = 437$ cu. ft. On the basis of a 12-inch rain producing twice as much, the total from the 1.35 sq. mi. would be 874 cu. ft., or a little more than 600 cu. ft. per second. This is unquestionably too low.

(5) The McMath formula is $Q = Ci\sqrt[5]{SA^4}$, the symbols being the same as for the Burkli-Ziegler formula above. Using $i = 4.4$ and $C = 0.75$ as in that formula, the runoff will be $Q = 0.75 \times 4.4\sqrt[5]{37 \times 834^4} = 1{,}650$ cu. ft., or $1{,}650 \div 1.35 = 1{,}220$ cu. ft. per second per sq. mile.

Most of these formulas appear to give rates that are too small, but they are valuable for checking. The rational method should be used, with a generous value for C.

9. *Charts and Curves of Flood Flows.*—Fig. 1 is a chart which shows the runoff as computed by the various formulas. Fig. 2 shows the expected runoff for areas up to 1000 acres, as stated in a report (Bulletin 121) of the Iowa Engineering Experiment Station.

10. *Spillway Capacity.*—a. The spillway capacity must, of course, be capable of passing the maximum flows, less the amount held in reservoir storage. In small reservoirs this storage should be neglected; although in large reservoirs it may be an important factor. If the area is 50 acres, and the depth over the spillway at maximum flow is 5 feet, the reservoir storage is 250 acre feet. If this storage is taken up before or by the time the maximum flow occurs, it will not reduce the load on the spillway. It is worked out by assuming an initial normal overflow at the spillway; determining for each increment of time (as 5 or 10 minutes in the case of small projects) the inflow into the reservoir and the discharge from the spillway; and computing by mass diagram methods the level in the reservoir.

b. Earth dams *must not* be overtopped, as overtopping invariably causes failure. Masonry dams may be designed to be safe if overtopped; with them, more serious damage usually results from erosion and wash at the ends of the dam. It is necessary in every case where overtopping of masonry dams may occur, to

provide protection against undermining and erosion.

c. The discharge over an excavated spillway where the entrance is sloped and there is a free flow at the outlet is : $Q = CLH^{3/2}$. Q is the discharge in cubic feet per second; C is a constant or coefficient having various values, depending on the shape of the overflow section (normally a value of 3.0 may be used for a smooth paved channel and 2.75 for a rougher channel, as riprap); L is the length of the weir, in feet; and H is the depth of water over the crest in feet.

Assuming, for purposes of illustration, that it is desired to design a spillway to care for the overflow anticipated in the example of Par. 8-c, with an estimated flood flow of 2730 cu. ft., as arrived at by the rational method, a tentative width of spillway of 60 ft. is adopted; C = 2.5; and a maximum depth of 6 feet of flow over the crest is assumed: Then $Q = 60 \times 3 \times 6^{3/2} = 180 \times \sqrt{216} = 2620$ cu. ft. This is not enough, and a wider spillway (62 ft.) must be provided, or the freeboard of the dam increased.

11. *Spillway Details.*—The common types of spillways are classed as overflow sections, open channels, side inlets and drop inlets. Overflow sections must be of masonry; in the case of earth dams, this means a masonry or concrete section of the dam is necessary. It is preferable to use a side channel, setting the spillway apart from the dam. Because spillway design is dependent largely upon the type of dam, it will be discussed further under the sections devoted to each type of dam.

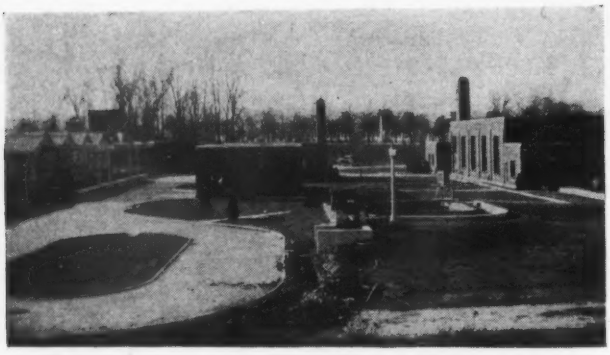
Copper Sulphate for Aquatic Nuisances

(Continued from page 21)

carbonates and bicarbonates react with the copper sulphate producing an insoluble copper compound. This insoluble compound, basic copper carbonate, was then shown to be non-injurious in hard water to fish. The rate of removal of the copper from solution as a relatively harmless precipitate is not, however, an instantaneous reaction. Several attempts were made without as yet very reliable results to fix exactly the actual rate of removal. In general, however, it was found that the majority of the copper is removed from solution in about one-half hour.

The fish used in the above tests were less than one year old and averaged about 4 inches in length. In order to ascertain that very young fish were not extremely sensitive to the chemical, a run was made with bass fry one and one-half months old and averaging one inch in length. Again the mineral matter of the hard water offered a protective action and these fish were not affected until a concentration of 80 p.p.m. was reached. The results indicate that the young fish are more susceptible than the older ones, but that there is still a large margin of safety present.

Results of the fish studies with various concentrations of copper sulphate have indicated: (1) The toxic doses of copper sulphate recorded in the literature for the various species of fish are correct only for distilled or very soft waters. (2) The mineral salts of hard waters remove copper from solution as an insoluble precipitate, thus increasing the amount of chemical which may be added before fish are killed. (3) The fatal dose for young large mouth black bass in hard water is 80 p.p.m.; for larger bass is about 160 p.p.m. (4) Very short exposures of fish to high concentrations of copper sulphate produce high mortality.



General view of Findlay, Ohio, plant. Main building at right; sludge beds and digester at left.

The Sewerage Digest

Abstracts of the main features of all important articles dealing with sewerage and sewage treatment that appeared in the previous month's periodicals.

Accelerated Reaeration

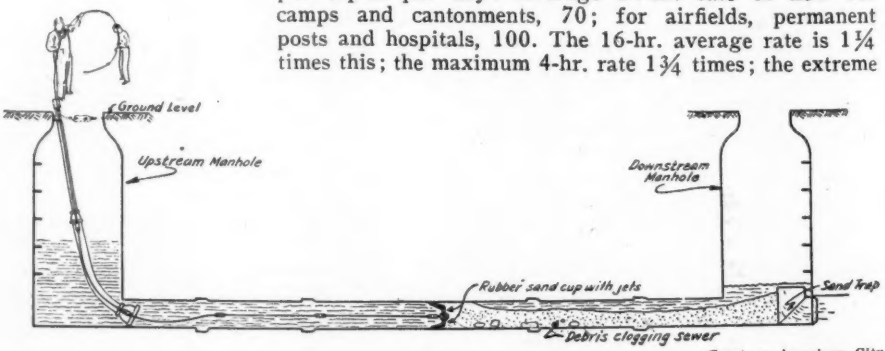
This is the name given by the author to his proposed new method of final treatment. This is, to discharge effluents high in oxygen demand into a stream, causing oxygen depletion through natural biochemical processes; then bring the dissolved oxygen content of the river up to any desired requirement by artificial aeration. The arguments favoring it are less cost and greater effectiveness of adding a pound of dissolved oxygen than of removing a pound of B.O.D.; blower equipment is more accurately controlable than are sewage treatment processes; and the requisite flora are always present in the stream. The process was suggested by the difficulty of satisfactorily treating sulfite waste liquor by biochemical means, since such liquor contains 15,000 to 55,000 p.p.m. B.O.D., as compared to the 150 to 250 p.p.m. in domestic sewage.[C58]

Studies of River Pollution

A survey of the Raritan River, New Jersey, in 1940-41 showed an increase in B.O.D. from 2.0 p.p.m. at Manville to 14.6 p.p.m. at Bound Brook 5 miles below, beyond which it decreased. The dissolved oxygen decreased from 81% saturation at Manville to 47.5% at New Brunswick, then increased to 75% at Perth Amboy. The D.O. saturation was decidedly lower in summer than in winter at all points, reaching zero at Bound Brook during low flow in late summer. Total bacteria reached a maximum at New Brunswick and E. Coli at a point 3 miles above. Both total bacteria and E. Coli were higher in summer than in winter at all points. Results showed an absolute increase of 19,820 lb. of B.O.D. between Manville and Bound Brook; and it was calculated that sludge deposits between those points exerted an oxygen demand equivalent to 12,440 lb.[C59]

Cleaning Sewers In Boston, Mass.

Boston's sewer department cleans sewers by the usual hand winch and bucket or by use of flexible rods and a rubber cup. Use of the latter began three years ago; ¼" steel rods 3' long are connected into a long flexible rod, which is shoved from a manhole into the sewer until it strikes an obstruction, when the rod is revolved by means of ratchets, drilling through the obstruction, no matter how hard, and starting flow. The rod is then equipped with a rubber cup slightly smaller than the sewer and having small holes around its circumference, the sewage that flows through the holes washing the deposits ahead as the cup is pushed ahead. The loosened deposit is caught by a sheet-metal trap in the downstream manhole and shoveled into buckets.[J11]



Courtesy American City

Cleaning sewer with flexible rod in Boston.

Slough, England, Sewage Works

The population of Slough increased from 18,500 to 33,500 in 1930-31, to over 50,000 in 1938, and at present is about 67,000. The sewage works have been enlarged, once in 1936-38 and (the population having increased 50% during construction) again in 1939-40. They are again overloaded and further enlargement is being planned.

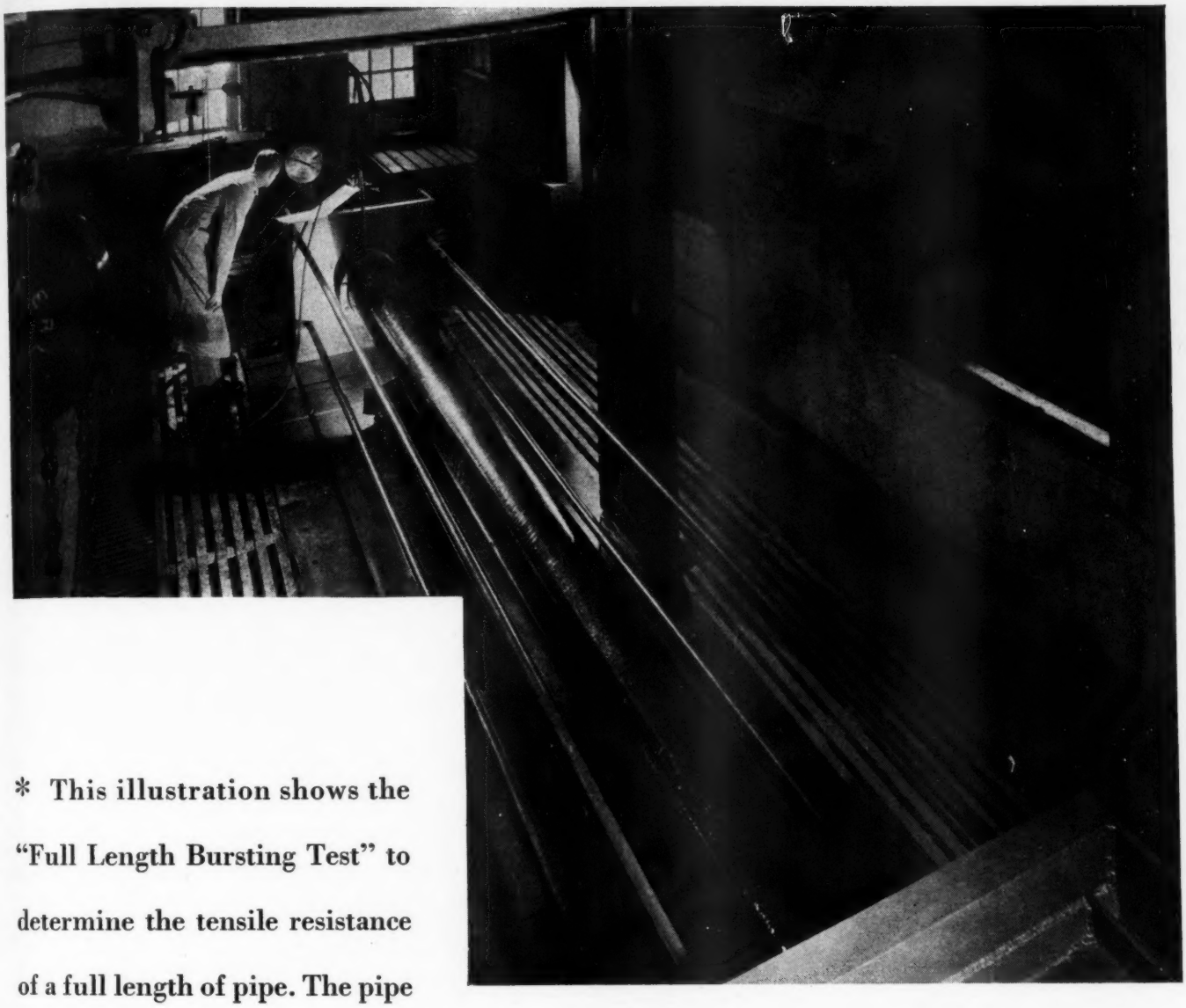
The present plant deals with 3,000,000 g.p.d., on an area of 194 acres, of which 151 is the original irrigation farm. Sewage passes through two detritus tanks and two mechanically cleaned screens, to a main inlet channel, provided with a storm-water overflow into four tanks, the overflow from which passes to old irrigation lagoons. Due to present overloading, these tanks receive overflow every day, which is pumped back to the main inlet at night.

After leaving the screens, the sewage receives 5 p.p.m. chlorine. Of that passing the storm-water overflow, 1/3 is diverted to the old treatment plant (sedimentation and percolating filters) and 2/3 to the new plant. This comprises six Dortmund tanks of 3 hoppers each, from which sludge is drawn to the digestion tank or pumped to the farm for land disposal, and the effluent passes part to the irrigation area and part to filters. Six filters (later increased to 12), 100 ft. diameter and 6 ft. deep, receive the sewage through revolving sprinkler arms. Six filters are filled with metallurgical coke and six with clinker, the relative efficiencies of which are being studied. The filter effluent passes through 6 humus tanks to the stream, and the sludge is pumped to either the digestion tanks or the farm. The five sewage and three sludge pumps are operated automatically.

There are 6 digestion tanks 18 ft. deep, designed to treat only half the sludge but actually treating all of it satisfactorily. Sludge is drawn onto 24 drying beds of 6" of coarse clinker and 3" of ash, underdrained. Demand for the dried sludge exceeds the supply.[D24]

Sewage Treatment At Army Posts

Recent experience with operating treatment plants at Army posts has provided data leading to a revision of some of the design factors. Based on data up to March 20, 1942, these factors as revised are as follows, in gallons per capita per day: Average 24-hr. rate of flow for camps and cantonments, 70; for airfields, permanent posts and hospitals, 100. The 16-hr. average rate is 1¼ times this; the maximum 4-hr. rate 1¾ times; the extreme



* This illustration shows the "Full Length Bursting Test" to determine the tensile resistance of a full length of pipe. The pipe is subjected to progressively increased hydrostatic pressure until failure occurs. Although not a required acceptance test, it is one of the additional tests regularly made by this Company to further check and maintain the quality of its pipe so that it will adequately meet severe service requirements. ***United States Pipe and Foundry Co., General Offices: Burlington, New Jersey.*** Sales Offices in Principal Cities.

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peak 3 times; the minimum 4-hr., 0.4 time. These figures are for designed populations of 50,000 or more. For smaller populations they are to be multiplied by the following factors: 40,000, by 1.1; 30,000, 1.25; 20,000, 1.5; 10,000, 2.0. These factors of safety are chiefly to allow for possible increases in population and for uncertainty as to civilian population. Increases over the original flow factors are due also to flow from post laundries (which did not appear in 1918 data) and to unusual infiltration due to hurried construction of sewers.

In revising design units of plant capacities, the per capita B.O.D. is increased from the normal 0.17 to 0.20 because the population is all adult. Fats and greases predominate in army menus, and new grease traps are being installed to eliminate clogging of sewers and plant piping and to reduce scum difficulties. The estimated B.O.D. removal percentages are as follows: Standard trickling filters 85-95; high capacity filters—single stage, 60-80, two-stage, 85-95; activated sludge and contact aeration 85-95; plain sedimentation and Imhoff tank, 40. Detention period in hours, based on 16-hr. average flow, 2.0 in primary tanks for filters, contact aeration, plain sedimentation and in all secondary tanks, and 1.2 hrs. for activated sludge. Applied B.O.D. loadings per day are 600 lb. per acre-foot for standard trickling filters, 3,000 lb. per acre-foot for high capacity filters. Eight hours aeration is required for compressed air activated sludge and 12 hrs. for mechanical aeration. Sludge digestion capacity, in cu. ft. per capita (using capacity factors of 1.1, 1.25, etc. as above); for heated tanks, 3.0 for filters, 4.0 for activated sludge, 2.0 for plain sedimentation; for unheated tanks increase these figures by 50%. For Imhoff tanks use 4.5 for sludge capacity of lower compartment. Suspended solids are assumed at 0.27 lb. per capita per day; ether-soluble 0.29 lb.

Aerators and tanks are not successful as grease removers and collecting and removing it at the source appears to be the only positive solution. The grease traps outside the mess halls were not cleaned and were insanitary; traps in kitchen sinks were very inadequate and no reasonable size could possibly collect and retain the grease. There is now being installed at all posts a cast-iron clean-out flow-control type tee at the end of the drain pipe to iron out flow fluctuations and reduce discharge rates and still give reasonable times of discharge, and cast-iron traps (ceramic since April 1) of 25 g.p.m. flow rate and 50 lb. of grease retention capacity at 90% efficiency.

Laundry waste is giving trouble at treatment plants and full-scale experiments in pretreatment show that using 25 g.p.g. of lime and 15 min. of aeration, followed by 30 min. of settling, reduces both B.O.D. and grease by about 35%.[C53]

Sewer Construction At Lockport, N. Y.

To eliminate inverted siphons under the barge canal, intercepting sewers were placed 75 to 80 ft. below the surface and built in tunnel. Sizes of 24" to 48" would give adequate capacity, but the tunnels were made 4 or 5 ft. wide by 6 or 7 ft. high, necessary for using modern construction methods. Tunneling was in limestone, which was self-supporting in most places, where concrete lining was placed in the bottom only. Under the canal, where there was leakage into the tunnel, the entire tunnel was lined; first drilling holes diagonally from the sides of the tunnel and forcing in concrete grout mixed with bran or cornmeal, which stopped the inflow sufficiently to permit placing the concrete, which was done in the bottom by use of cement guns, forms being used for lining the top and sides.

Several sewers were built in narrow valleys with steep irregular rock sides in which it would be difficult to place sewers underground. In these valleys Armco asbestos-bonded corrugated pipe was used, in some places completely exposed on trestles, in others under deep fill. At

the lower ends of the valleys they were laid below the hydraulic gradient because of the surface topography, and were required to leak, under 11 lb. per sq. in. pressure, not more than 0.1 g.p.h. per joint for 15" pipe and 0.2 for 24".

The houses along a steep bluff discharge into a sewer at the bottom of same through the same type of pipe, most of these connections being simply fastened to the face of the rock. These tend to freeze in extremely cold weather, due to trickling flow from leaky plumbing in the houses.[C54]

Separating Grease from Sewage

Quiescent settling of 27 samples of sewage gave average removal of 62% of suspended solids and 47% of grease. The grease content of the non-settleable solids was higher than of the settleable solids. The higher the original concentration of grease, the greater the removal. The grease content of sewage decreases during long periods of quiescent standing, faster at 20° C than at 7°, probably due to bacterial action. Pre-aeration or preflocculation increases removal of suspended solids by sedimentation, both in about the same percentage; but the grease content of the additional solids removed by aeration was higher than by mechanical flocculation.

Grease in sewage is practically all in suspension and nearly all can be removed by proper chemical treatment. Low dosages of copperas remove most of the grease although giving poor general clarification. Plant-scale experiments gave average grease removal in the scum of 55 lb. per m.g. by aero-chlorination as compared to 39 lb. by plain aeration, and there may be additional grease broken from the emulsion form by chlorination and settling with the solids.[C55]

Riboflavin In Sewage Sludge

Riboflavin is the chemical name of the compound formerly known as vitamin G and at present known as vitamin B_2. It is essential to the growth of certain bacteria. It is found to be present in high concentration in sludges from secondary sewage treatment and in lesser amounts in primary tank sludges, the content varying in the same direction as the organic nitrogen and volatile matter. The growth-promoting effect of riboflavin on plants and on seed germination should be studied. It is possible to prepare riboflavin concentrates from sewage sludges and use them as animal fed supplements.[C56]

Bio-Filter Plant For an Army Camp

Disposal works for a camp where troop population may vary from 3,500 to 35,000 called for unusual flexibility. Bio-filtration was adopted, using duplicate sedimentation units, filters and final clarifiers, any one or all of which may be operated in almost any manner to produce a varying degree of treatment, or a fixed degree of treatment regardless of flow variations. The clarifiers can be used in parallel or in series and the other units bypassed; or two clarifiers and one filter, or one clarifier with two filters. Each unit can be drained completely. About 3,000 ft. of the 5,000-ft. 30" outfall sewer on a 0.1% grade, giving 30 min. of flow, is used as a chlorination chamber. Sludge and scum from two primary clarifiers will be pumped to the primary digester; those from the secondary clarifiers to the incoming sewage, to which also may be returned digester supernatant and sludge bed filtrate. It is expected that the effluent will have 30 p.p.m. of B.O.D., 35 p.p.m. of suspended solids and 50% dissolved oxygen saturation.[E12]

Studies in Biofiltration

Preliminary results of biofiltration research conducted by means of a pilot plant at New York University (See "Sewerage Digest" for January, 1942) are reported.

Sewage strength varied from 80 to 120 p.p.m. B.O.D., and 80 to 150 p.p.m. suspended solids. Six runs were made, 4 single-stage and 2 two-stage. The recirculation ratio was 1:1 in all but one run, when it was 2:1. The actual filter dosing rates were 32.6 m.g.a.d. in the first two runs, 66 m.g.a.d. in the later ones; the latter gives as good results as the former, indicating that the lighter dosage was uneconomical with this sewage. It also appeared that recirculation ratios greater than 1:1 are not warranted for such weak sewage; and if better B.O.D. removal than 80% is desired it is advisable to recirculate both clarifier effluents back through the filter, rather than use a secondary filter.

The rate of B.O.D. removal increased with the loading up to the maximum load of 5.26 lb. B.O.D. per cu. yd. per day. Considering primary filter and primary clarifier as a unit, the removal was directly proportional to the load applied, up to a load of 5.48 lb.[H41]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n,* note or short article; *p,* paper before a society (complete or abstract); *t,* technical article.

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53. Sewage Treatment at Army Posts. By Lewis H. Kessler and John T. Norgaard. Pp. 757-783.
54. Varied Problems in Design and Construction of Sewers at Lockport, N. Y. By Walter R. Drury. Pp. 784-798.
55. *t.* Separation of Grease From Sewage by Mechanical and Chemical Methods. By Harry W. Gehm. Pp. 799-810.
56. *t.* Riboflavin in Sewage Sludge By L. S. Kraus. Pp. 811-817.
57. Studies on the Treatment of Sewage and Textile Wastes by Recirculating Filtration: Domestic Sewage on a Continuous Basis. By Robert K. Horton, Ralph Porges and Herman G. Baity. Pp. 818-833.
58. **Accelerated Reaeration. By Richard** G. Tyler. Pp. 834-838.
59. Raritan River Pollution Studies. By Willem Rudolfs and H. Heukelekian. Pp. 839-865.
60. Priorities. Pp. 866-867.
61. House Laterals and Connections. By Harold J. Huber. Pp. 867-870.
62. Disposal of Liquid Sludge at Kankakee, Ill. By Phillip J. Schriner. Pp. 876-878.
63. Odor Control, A Symposium. Pp. 883-890.

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22. Effects of Paper, Moisture and Chlorides Contents. P. 253.
23. *p.* Manurial Value of Sewage Sludges. By E. M. Crowther and A. H. Bunting. Pp. 255-258.

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24. *p.* Borough of Slough Main Sewage Works. By M. A. Kershaw. Pp. 265-267.

E — *Engineering News-Record*
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12. Army Bio-Filter Sewage Plant Provides Unusual Flexibility. Pp. 69-71.

G — *Water Works & Sewerage*
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20. Sewage Chlorination for Odor Control. By H. Heukelekian. Pp. 302-304.
21. Sludge Digestion Temperature Control With Live Steam. By A. M. Rawn. Pp. 310-313.
22. Cleaning Encrusted Pipe Lines and Vacuum Filters. By K. L. Mick. P. 314.

H — *Sewage Works Engineering*
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40. Economy in Design and Operation Stressed at Greenfield, Mass. By E. Sherman Chase and Frank L. Flood. Pp. 386-390.
41. Biofiltration Studies at New York University. By George P. Hanna, Jr., Albert Phimister and Rolf Eliassen. Pp. 391-394.
42. *p.* Dilution by Canal Water Permits Primary Treatment at Lockport, N. Y. By W. R. Drury. Pp. 395-398.
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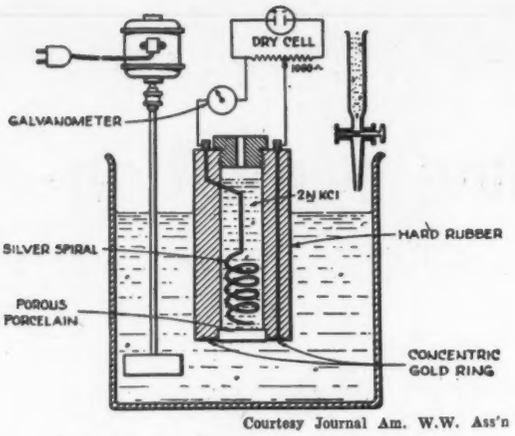

Courtesy Journal Am. W.W. Ass'n

Apparatus for determining residual chlorine.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Determining Residual Chlorine

Most of the limitations of known methods of determining residual chlorine in water result from the fact that the solution is acidified during the determination. Titration with sodium thiosulphate in neutral solution can not be classed as a quantitative determination. The author describes a method of titrating the chlorine amperometrically with sodium arsenite in neutral solution, using a polarized gold electrode and a silver chloride reference electrode. In the absence of potassium iodide only the free chlorine is titrated, while in the presence of potassium iodide both free and combined chlorine are titrated. Combined chlorine consists essentially of monochloramine and dichloramine. The determination of free and combined chlorine probably will be found useful in the treatment of water with chlorine and ammonia.

Using apparatus shown above, the chlorine present allows current to flow between the electrodes. As arsenite is added it reduces the chlorine and this in turn reduces the current. When all the chlorine has been reduced, further addition of arsenite causes no change in current, determining the end point of the titration. Current change is shown by a galvanometer needle. The chlorine-containing water surrounding the gold cathode is kept agitated by a paddle.

As the method is a direct titration, its accuracy is inherent. It gives correct results within pH limits of 6.5 to 8.0, temperature limits of 32° to 77° F, and in the presence of most of the substances usually found in water, including those causing color and turbidity. The limit of sensitivity is 0.01 p.p.m. chlorine.[A110]

Power for Pumping Plants

Most pumping plants are driven by electricity. Where coal is cheap, steam turbines may be economical. In some localities water power may be preferable, in other cases diesel engines. Gasoline engines, due to the high cost of fuel, are rarely used for continuous duty in waterworks pumping stations, but are useful for standby.

For small high-speed pumps the squirrel-cage induction motor is the most reliable and economical, but for large pumps and lower speeds the efficiency and power factor of the induction motor decreases, so that the synchronous motor is more economical. The wound rotor induction motor, with adjustable speed control, is useful where speed regulation is desired. The synchronous type of motor is useful for power factor correction; where variable speed in a pump drive is required, a variable speed coupling must be used, and these are quite costly.

For small full-voltage-starting induction motors, the simple magnetic starter, with overload and under-voltage protection, is the most popular type of control, especially where the pump is controlled automatically by pressure switch or time switch or operated from a remote point. The control of synchronous motors is somewhat more involved, but it is not unduly complicated if arranged for full-voltage starting and automatic synchronizing.

The total cost of pumping may be reduced by operating electric motors at nearly 100% load factor and carrying the balance of the load with steam turbines operating for short periods only. Most steam turbines operate at speeds much higher than are suitable for centrifugal pumps so that speed-reducing gears must be used. Diesel engines are quite reliable and in some cases economical for pump drives, but are not much used, possibly because their speeds are much lower than required for direct connection to centrifugals. Gasoline engine speeds permit direct connection for moderate heads, but for low heads reducing gear may be necessary. Gasoline engines require 0.65 lb. of gasoline per h.p.hr. and cannot be used economically for continuous duty.[A111]

Experiments With Tube-Loy Pipe

This pipe consists of about 99.7% lead alloyed with 0.25% tin and smaller amounts of calcium, magnesium and bismuth. It is made in sizes of ⅜" to 2", of two types of different wall thicknesses, approximately one-half those of classes AA and AAA lead pipe but safe for higher working pressures. Joints can be wiped, or standard flare-type or sweat-type. Where desired, it is furnished with an inside coating of lead chromate. Tests of solubility in water at Milford, Mass. (where serious lead poisoning has been caused by use of lead pipe) showed the Tube-Loy pipe to be more resistant than lead, especially with the chromate coating.[B22]

Odor Removal with Aeration and Activated Carbon

Comparing the efficiencies of these two methods for removing taste and odor, it was concluded that aeration was of value in removing CO_2, hydrogen sulfide, manganese or iron, but for removal of taste and odor alone was not economical. In general it might be preferable for seasonal tastes due to microscopic organisms in waters unpolluted by sewage or industrial wastes, where sufficient head is available without additional pumping, or even with pumping where the water is not filtered on rapid sand filters; or in supplies where pre-chlorination is practiced, since aeration may reduce the chlorine demand while activated carbon would increase it.

Activated carbon would be more feasible for supplies treated by rapid sand filtration where its cost would be less than that of additional pumping needed for aeration, or where aeration would not be effective for the types of odors encountered, where it would prevent growths of algae in coagulation basins or odors due to decomposition of sludge in such basins, or where it may be applied with coagulants without the use of additional equipment.[B23]

A Relocated Pre-Planned Town

The site of Hill, N. H., a town of 120 families, will be flooded by a Federal flood-control reservoir now nearing completion. The town and the individual home owners

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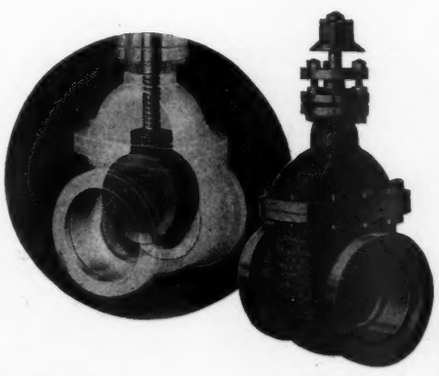

LUDLOW VALVES
SINCE 1866

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were compensated by the government for roads, bridges, public and private buildings and utilities, and decided to use the money (plus $40,000 water works bonds) for reconstructing the village (whose origin dates to 1768) on high land near the old site. Aided by advice of the State Planning and Development Commission, the town had plans prepared by architectural and engineering consultants; and after these had been explained to the townspeople by perspective drawing and scale models, they were adopted and built. Private residences were individually planned and built on lots of a half acre or more, restricted to colonial design.

The town is located a little to one side of Route 3A, between which and the town is a strip of parking. The shopping center is on a bypass near the highway. New stores must be approved by the town. Approximately half the village area is publicly owned for parks, etc. A non-profit improvement association holds options on all available land to prevent land speculation. The old waterworks was abandoned and new ones built with capacity for 800 population, with a gravel-packed well 40 ft. deep, motor-driven 115 g.p.m. turbine pump, 274,000 gallon steel standpipe and 15,000 ft. of 8" and 12" transite pipe.[B25]

Emergency Repairs Of Distribution System

To receive notice of damage at night by telephone, a watchman may serve, or all calls can be routed to some station where men are on 24-hour duty; or certain jobs, such as auto maintenance, can be done at night, so some men will be near the telephone. To prevent delay in telephoning to the office by men on the job, many utilities have installed unlisted telephones in their service departments, the numbers being known only to foremen and other key men. Calling out an emergency crew is best done by the chain method, one member of each crew being called from the office and he calling the others. Each man must know beforehand where he is to report and whom he is to work with.

Closing the necessary valves, uncovering and dewatering the break and repairing the pipe may take an hour for each inch diameter of the main if a fitting has to be replaced, half this time for repairing a pipe break with a solid sleeve, and a quarter for repairing it with mechanical joint. Valve-operating equipment is desirable, either truck mounted, driven from a power take-off, or motor-driven from an air compressor or portable electric generator. For night lighting, electric generators are more satisfactory than acetylene, permitting flooding the entire site with light from easily portable equipment.

For handling pipe 20" or larger, a truck-mounted crane is desirable; tripod derricks with 2" pipe legs will serve for smaller pipe. If mechanical joint repair fittings are used, the valve closure need not be as tight as with poured joints, nor the excavation so completely dewatered, nor the pipe ends cut so true. Wooden plugs, to fit 4", 6" and 8" pipe permit quick temporary stoppage of water waste. For sterilizing small mains with hypochlorite, small iron force pumps with rubber check valves are fine.

In Chicago, the office force is trained in closing and opening valves, each man actually operating a valve. Different valves are used each time and thus all valves in the systems have been checked as to their operating condition.[A108]

Thin Coating Of Steel Pipe

In coating 9330 ft. of 14" steel pipe, San Francisco used a new "hot plate" method of applying enamel coating that permitted a thickness of 1/32 in. instead of the usual 3/32 in. The pipe, in 30 ft. lengths, was spun at 1100 rpm and at the same time heated to 325° by means of a double row of gas burners under the entire length of the pipe. The hot enamel was then applied by tipping a trough filled with it that extended inside the pipe for its full length and was at once withdrawn when empty. Then 2000 cu. ft. per min. of air was blown through the pipe,

and after 30 sec. cold water was sprayed into it and carried through the pipe by the air, cooling it to below 200° in about 2 min. The blowing was important as it halved the cooling time, eliminated wash marks, corrugations and pock marks and made the entire process more easily controllable. In this method no primer coat is used. Experiments using coal tar pitch in place of enamel gave as good appearance, smoothness and bond but the pitch tended to be brittle. The outside coating was applied in two layers giving a total thickness of 1/32 in., applied by pouring on the pipe revolving at 8.7 rpm and spreading with hand-operated squeegees.[E18]

Honolulu's War Preparation

The Water Board of Honolulu began war precautions 17 years ago, establishing 3 main steam pumping stations, interconnected. This cost 7 times as much as electrical units powered from a central generating plant, but the cost figures about the same over a 30-year amortization period.

Active preparedness began early in 1940. Several 500-m.g. reservoirs above the city, which might flood it if bombed, were lowered to 20% capacity. Since Pearl Harbor, all pumping station personnel has been armed with riot guns, pistols and helmets and drilled in marksmanship. In December, 1940, one and two-way radios were purchased for all principal field units, operating through the police radio system. Since April, 1941, $209,000 has been appropriated for man-proof fences and excess supplies. (These have to come 2,000 miles by water). All lights in pumping stations were reduced to 6 watts, and those from which there might be reflections against polished machinery were supplied with ruby globes. Pin-point white lights were placed behind oil sight glasses and ruby lights at water and steam gauges. Since blackout rules prevent travel on streets at night, a night pumpman works from 4 P.M. to 8 A.M., then is off for 32 hours (increased to 56 hours once a week). The morning shifts at pumping stations work from 8 A.M. to 4 P.M., with one day off each week. If possible, pumps are shut down during raids since less damage is done by bombs to machinery not in motion. The waterworks control center is an underground station blasted out of solid rock, where are centered telephone, radio and messenger communications and gauges showing pressures at various points. No one but qualified water workers are permitted to touch street valves, even after raids. All employees receive red cross first aid training and gas first aid. Night storage of rolling stock is decentralized, distributed throughout the city, and their crews were reorganized according to residence localities and given night custody of their equipment. Certain vehicles are marked with a white patch 1 ft. square giving them right of way into all blitzed areas during an attack. At least one executive is present at the water supply building every night.[A104]

Metalizing a Water Tank

Erie, Pa., eight years ago repaired a heavily corroded and pitted steel tank by spraying molten zinc in two layers on areas previously sand blasted. After eight years of uninterrupted service there is no sign of failure of the coating. Metalizing costs 2 to 2½ times as much as good painting but apparently is more economical in the end.[E19]

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The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n*
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104. Honolulu Wartime Water Works Activity. By Frederick Ohrt. Pp. 1141-1162.
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17. Municipal Water Charges to Industrial Users. By Arthur C. King. Pp. 133-135.
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G *Water Works and Sewerage*
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34. Tests on the Cathodic Method of Protecting Steel Water Tanks. By Gordon L. O'Brien. Pp. 285-291.
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33. Maintenance of War Supplies Under War Conditions. Pp. 29-32.

W *Johnson National Drillers Journal*
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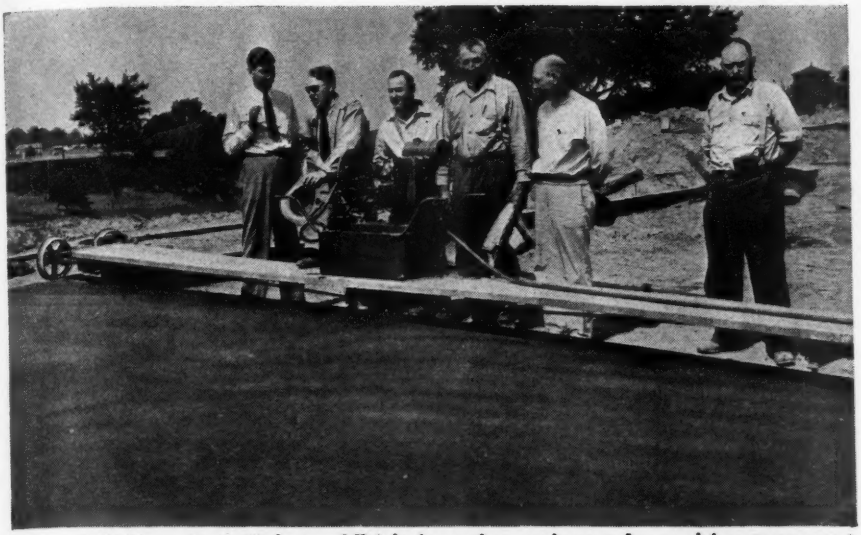
7. Hydraulics of Wells. Pp. 1-7.
8. Equipment for Exploring Wells. By Penn. P. Livingston. Pp. 10-13.

V *Journal, Maine Water Utilities Ass'n*
July

6. Fuels and Their Relation to the Present and the Future. By C. C. Turner. Pp. 91-98.
7. Hazards to Water Supplies From War Gases and Other Poisons. By E. Sherman Chase. Pp. 99-101.

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 65-67

Keeping Up With New Equipment



Group of Michigan State Highway Officials inspecting equipment for applying transparent concrete Truscon Tru-Cure compound at the start of pouring on new road in the Ford Bomber, Willow Run, Traffic Project. Reading from left to right: Homer Cash, *State Highway Construction Engineer;* Keith Baguley, *Project Engineer;* M. H. Goldsmith, *Office Manager for Oak Construction Company, Royal Oak, the highway contractor;* H. Foss, *Superintendent for Oak Construction Company;* J. M. McCavey, *Sec.-Treas. Oak Construction Company;* Clarence Sandin, *State Slab Inspector.*

New High Water Retaining Concrete Curing Compound

Truscon Laboratories, Detroit, Mich.

Of interest to contractors and especially road builders is the newly developed concrete curing compound which has been used with such outstanding success on several large war jobs and highways — considerably expediting construction and producing concrete conforming to the very highest standards.

Tru-Cure, produced by the Truscon Laboratories of Detroit, is a clear liquid which is sprayed on the wet concrete immediately after finishing. When used on formed concrete it is applied as the forms are removed.

Big advantage claimed is that Tru-Cure seals and locks in the moisture immediately as soon as the finishers are off the work, saving from several hours to a day's time usually lost on the average concrete job before curing can be started.

Tru-Cure is said to produce the equivalent of a 14-day water cure without the labor expense of hauling dirt and keeping surfaces wet.

Inasmuch as it is generally agreed that the first day of curing, and in fact even the first few hours following finishing, are so exceedingly important in the life of concrete—the very high early moisture retention of Truscon Tru-Cure is of interest to every building or highway engineer, or contractor.

The producer says laboratory tests have proved that Tru-Cure has moisture retaining qualities of very high limits—better than 96% at 24 hours at a temperature of 110° F, or 90% at 7 days; and that with Tru-Cure the curing process starts sooner, thereby largely eliminating crazing and such shrinkage cracking as results from too rapid moisture evaporation soon after the concrete is placed.

For more detailed information, write the Truscon Laboratories, Detroit, and ask for Bulletin No. 534.

A Better Luminaire for Streetlighting

Westinghouse Electric & Mfg. Co. East Pittsburgh, Pa.

A better street-light as the result of the aluminum shortage has recently been developed by Westinghouse lighting engineers.

Some new way to maintain quality had to be found — and it was, in mirrored glass. Although reflectors for street lamps had never been made of silvered glass, it was found possible by new techniques to make one that would fit into a hood made of still-available sheet metal. The result is a fixture every bit as good in performance as one with an aluminum reflector — and better in some ways. Because a clamping ring had to be used to hold the glass globe to the hood, the old aluminum unit used to cut off all light from the lamp above a 70° angle with the vertical. The new glass-reflector unit does not have this limitation, and has a cut-off angle of 75°, meaning that a much longer stretch of street can be lighted from single luminaires. Also the glass reflector has a high reflection factor and can be returned almost to its original high reflecting power by simple cleansing.

Cuprinol A Rotproofing Chemical

Cuprinol, Inc.
7 Water St., Boston, Mass.

A Danish scientist invented a rotproofing chemical that protected the nets from rotting but didn't hurt the skin of the men using the nets nor poison the fish caught. After this demonstration of the effectiveness of Cuprinol in protecting fishing nets from rot, it has been demonstrated that Cuprinol would also protect wood from fungi and insects. It is claimed to be harmless to higher forms of animal and plant life and is easily applied with paint brush, spray gun, or by dipping, and can be varnished or painted over. It has no offensive odor, is not poisonous, and does not corrode metal. Cuprinol is not a tar product but is manufactured from organo-metallic salts under direct and exclusive license from England. Over there it has been adopted by most of the government departments to stop rot and insect attack in wood and fabric materials used in Britain's war program. Write for booklet giving complete information regarding this rotproof chemical.

Priorities Clinic Will Feature Sewage War Conference

Annual Meeting of the Federation of Sewage Works Associations, Hotel Statler, Cleveland, Ohio, October 22-24

W. H. Wisely and L. E. Rein, President, Pacific Flush Tank Company, will give advice and guidance to those municipalities faced with immediate need for materials and equipment. The entire convention will have a wartime character. A. M. Rawn and H. G. Baity will discuss the impact of war on sewage treatment problems. L. H. Kessler and Guy Griffin will present data on the operation of sewage treatment plants in military cantonments.

Dr. J. V. Dorr, President of the Dorr Company, will be a feature luncheon speaker.

The meeting is timed to meet the restrictions on travel. One trip will permit members to attend the meetings of the Federation and to participate in the session of the American Public Works Association to be held in the same hotel during the four days prior to the Sewage Works Conference.

ARBA President Sherlock Enters Engineer Corps as Major

Chris J. Sherlock, president, American Road Builders' Association, Montgomery, Ala., has been commissioned a major in the Corps of Engineers, U. S. Army. He is assigned as operations officer for the Denver, Colo., district of the corps. This appointment became effective on his arrival in Denver, July 6. He served for almost three years as Alabama state highway director, resigning this post last February. The first southerner to head the international highway organization, he was installed as ARBA president at the annual convention in Memphis, Tenn., March 2-5.

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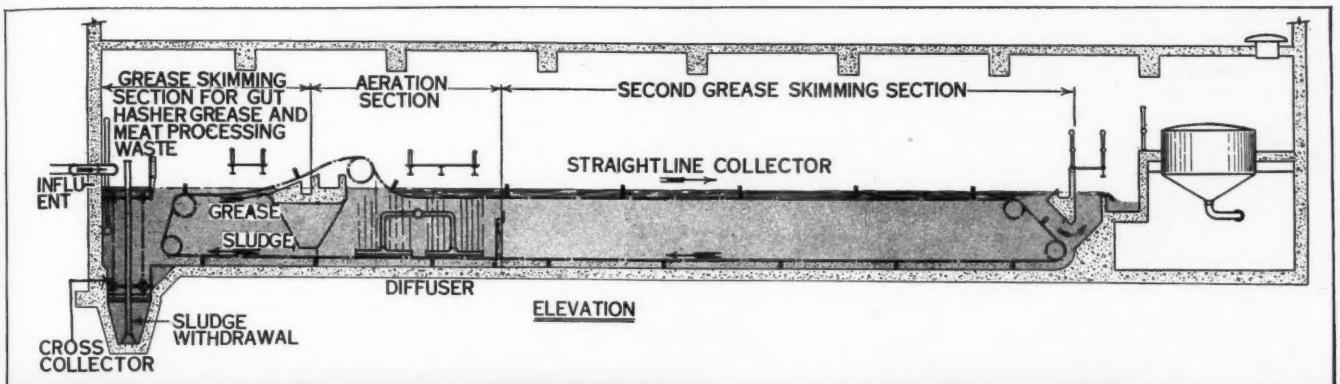
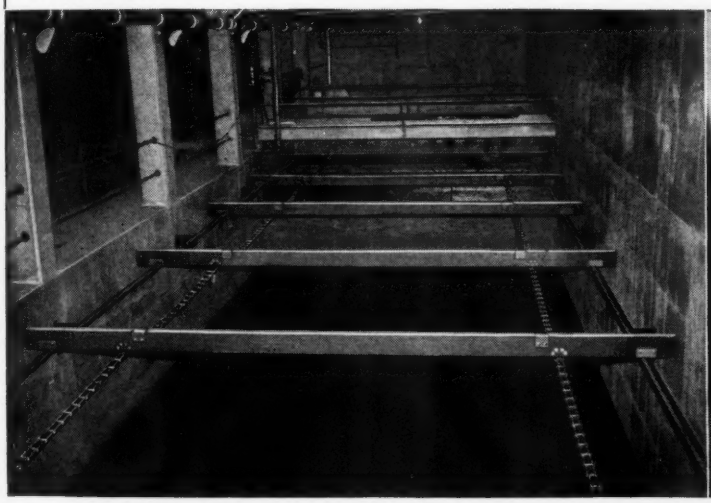
How a Meat Packer Recovers Grease Formerly Lost in Liquid Wastes

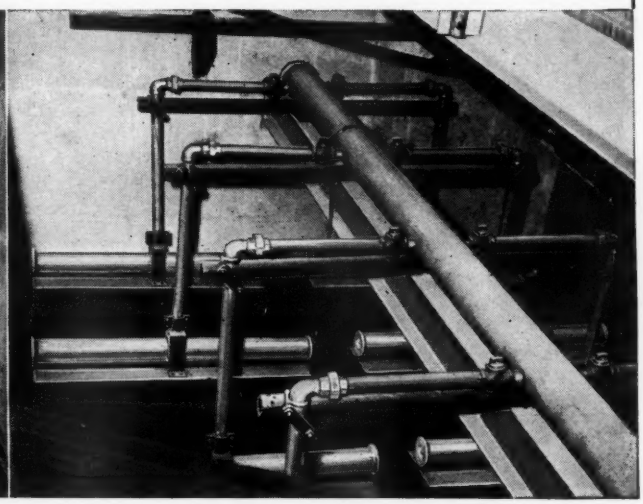
STRAIGHTLINE COLLECTORS REMOVE SOLIDS—SKIM OFF FLOATING MATERIAL

A 75% increase in grease recovery has been attained with the system illustrated below. The first section of the tank receives the combined gut hasher and meat processing plant wastes. The baffle marking the end of this section, also serves to support a grease receiving trough extended across the tank at this point and emptying to a pit adjacent to the tank. The second section of the main grease separating tank serves as the aeration section for all wastes being treated for grease removal. Into this section the flow from the main plant is introduced from an influent channel projecting across the tank at the end of the first compartment and mixes with liquid which has passed through the first skimming section. The third section serves as the final skimming and settling compartment for all flow being treated.





STRAIGHTLINE Collector with tank partially empty.



Link-Belt Air Diffuser Unit.

Solid matter which settles out of the flow is collected by the STRAIGHTLINE sludge collector and moved to the front end of the first section of the tank. A STRAIGHTLINE cross collector operates in a trough at the end of the tank and conveys the sludge to a sump at one corner of the tank, from which it is pumped to the municipal sewage plant.

The same Link-Belt collector skims the floating material from the liquid surface. At the end of the first skimming section, the collector drags the grease up a concrete deck or apron into the trough. After depositing this accumulation of grease from the first section, the collector continues over the trough and baffle and down into the liquid again to move grease in the final section, to the trough at the effluent end of the tank.

THROW YOUR SCRAP INTO THE FIGHT

Let us tell you more about this interesting system. Send for Folder No. 1946. Link-Belt Company, Philadelphia, Chicago, Cleveland, Indianapolis, Los Angeles, Toronto. Offices in principal cities.

8031

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When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 65-67

A native of Americus, Ga., where his parents, Mr. and Mrs. C. J. Sherlock, Sr., still reside, Major Sherlock was graduated from the Georgia Institute of Technology in 1920. While an undergraduate, he was a member of the Reserve Officers Training Corps in 1918. He served the Alabama highway department as computer, draftsman, inspector, instrumentman, resident engineer, division engineer, assistant chief engineer and chief engineer before assuming the directorship in 1939. A recognized expert in highway and bridge engineering, he has also served as vice-president of the American Association of State Highway Officials.

His wife, the former Leonora Chapman of Troy, Ala., and their four children, Marguerite, Christopher Joseph III, Eugene and John Alexander, remain at their home in Montgomery.

Flexible Pipe Research Reported

Flexible pipe culverts made of corrugated metal are able to support the weight of high earth embankments chiefly because of the lateral support of the pipes by the soil in which they are embedded. Such is the report of M. G. Spangler, research engineer of the Iowa Engineering Experiment Station, presented in Bulletin 153 of the Station, which has been issued recently.

Design data for calculating the supporting strength of flexible pipe are developed in the bulletin from both theoretical analysis and field experimentation. The design analysis is a result of an extensive research study, conducted in cooperation with the U. S. Public Roads Administration, which included full-scale field experiments on pipe as large as 60 inches in diameter under earth embankments 15 and 16 feet high. One of the experiments has been in progress for more than 13 years, and thus furnishes data on long-time increases in pipe deflection.

In addition the study included laboratory tests on full-size pipes. The bulletin also reports the performance of a flexible pipe culvert 15 feet in diameter, installed under a 42-foot fill in accordance with the design principles presented by Mr. Spangler.

Professor Spangler's study reveals that the thin-ring elastic analysis is valid for calculation of deflections of corrugated-metal pipe. This analysis is used as a basis for deriving a design formula for pipe deflection which evaluates the effect of fill load, pipe size, bedding, properties of the soil, moment of inertia of the pipe wall, modulus of elasticity of the metal, and time of service. Techniques for determining these design factors are presented in the bulletin.

The field experiments show that a corrugated-metal pipe will deflect an additional 25 to 50 per cent after the earth fill over it is completed, although several years may elapse before the maximum deflection occurs. Predeformation of large pipes by vertical struts increases the load they will carry without excessive deformation.

The bulletin does not discuss the durability of the various metals used to make corrugated-metal pipe culverts, nor is the design theory verified experimentally for low heights of fill and large vehicle wheel loads. However, the theory is general and should apply regardless of the load source, Mr. Spangler believes.

The complete research study is reported in Bulletin 153, "The Structural Design of Flexible Pipe Culverts." Single copies of this 80-page bulletin may be obtained without charge from the Iowa Engineering Experiment Station, Ames, Iowa.

"A Guide to Wartime Care of Electric Motors"

Allis-Chalmers Mfg. Co.
Milwaukee, Wis.

This is the title of what the publishers call a maintenance handbook giving vital information in regard to wartime care of electric motors. The information applies to all makes of standard general purpose motors. It treats separately each factor opposing long and trouble-free motor life. The heading of the first section is "Electric Motor Enemy No. 1 —'Dust'." Others deal with moisture, stray oil, friction, vibration, misalignment, uneven wear, overload and underload. Another section is headed "Quick Diagnosis of Motor Ailments" and is broken down into symptoms you can see, and feel, and hear, and possible causes and cures appear beside each symptom. Copies will be mailed free to any executive, engineer, or maintenance man sending for it on his company's letterhead.

"Plastiment"

Sika, Inc.
35 Gregory Ave., Passaic, N. J.

In a 20-page booklet Plastiment is described and its use illustrated. The manufacturers claim that the product is the medium by which all necessary properties of concrete are substantially improved, not only as regards comprehensive strength, but also in regard to every phase of technical prerequisites. The product is in powder form and its amalgamation with concrete is easy. To each bag of portland cement one pound of Plastiment is added. No special mixing is required. After the proper amount is added to the cement, the action of the conventional concrete mixers is sufficient for proper distribution and amalgamation. Write the manufacturer for a copy of "Plastiment."

Sewage Equipment

Designed, Manufactured by
Graver Tank & Mfg. Co.
East Chicago, Ind.

Graver equipment includes aerators, agitators, automatic dosing siphons, chemical feeders, chemical proportioners, chemical treatment plants; clarifiers, primary and secondary; coagulators, digesters, grease removal equipment, gas holders, Imhoff combination clarifiers, reactivator clarifiers, rotary distributors, skimmers, sludge conditioners, sludge dryers, sludge filters.

All of these are described in an 8-page bulletin—form 311—including a number of diagrams showing examples of a great variety of plant layouts which can be furnished. Copies of this bulletin are available upon request.

Economics of Water Meter Testing and Repairing

Neptune Meter Company
50 West 50th St., New York, N. Y.

In a new booklet published by Neptune Meter Company, the importance of testing and repairing meters is emphasized and practical suggestions are made on how to do it. Details are given showing how water works incomes are frequently reduced to a marked extent by allowing meters to deteriorate to such an extent that small flows go through the meters and are entirely unrecorded or greatly under-registered. A copy of this bulletin is available on request.

Preventing Detrimental Frost Heaving

Calcium Chloride Assn.,
Penobscot Bldg., Detroit, Mich.

In an information sheet the association says "It is particularly important that disruptive frost action should be prevented in the base courses which serve as the load carrying structure for flexible type surfaces. Some sub-grade treatment also is warranted where subgrade soils are comparatively unstable and where more severe climatic conditions prevail.

"The use of calcium chloride as an admixture in compacting soil-aggregate and subgrade soils serves a double purpose; in minimizing the ratio of water voids by increasing the density, and by giving antifreeze properties to the soil moisture.

"Compaction tests have shown that a soil, which compacted to 97 lbs. per cubic foot with an optimum moisture content using plain water, attained a density of 108 lbs. per cubic foot under the same compaction when calcium chloride solution was used. The 11 per cent increase in density represents a very substantial reduction in the total voids or moisture absorbing capacity of the soil.

"The combination of increased density and lowered freezing point attained in calcium chloride treated soils provide a means for positive attack against the forces which cause detrimental frost heaving. However, the necessary depth and the permanence of such treatment remains to be determined and is being studied under a fellowship with the Engineering Experiment Station of Purdue University."

Copies of the Brief F-61 are available on request to the association.

Earth Moving Equipment

La Plant-Choate Mfg. Co.
Cedar Rapids, Iowa

New high speed earthmoving equipment is described in a 16-page booklet well illustrated. It describes the scraper thoroughly, tells of the history and development and describes the many de-

sign features, the bowl, hydraulic system, wheels and brakes. Included also is a section on the TW-10 "Carrimor" Scraper which is the same machine with front wheel assembly for use with track-type "Caterpillar" tractors.

Copies of the booklet may be obtained by writing the manufacturer.

Concrete Spreader

Blaw-Knox Co.
Blawnox, Pa.

This company announces a new model Transverse Blade Concrete Spreader for airport and road building, with width adjustments up to five feet. By means of the adjustment, a 10 foot spreader will extend to a maximum width of 15 feet, and a 20 foot to a maximum width of 25 feet.

The company offers a bulletin on this new spreader which shows the method of its operation in a step-by-step series of photographs and sketches. Also illustrated is the Blaw-Knox vibrator.

Copies of this bulletin, number 1851, will be sent upon request.

A.S.T.M. Standards on Mineral Aggregates

This publication issued by the American Society for Testing Materials in December, 1941, is the first special compilation of specifications, definitions, and methods of sampling and testing mineral aggregates. Fifty standards are given in their latest form. While most of the specifications pertain to concrete and concrete aggregates and to road and paving materials, there are standards pertaining to the following fields: lime, gypsum, masonry mortar, glass products, waterproofing and roofing materials.

The 29 specifications given carry standard requirements for such materials as concrete aggregates, sand for use in plaster, lightweight aggregates, crushed stone, mineral filler, gravel, etc.

Also 21 standardized methods of sampling and testing are described—all of these being used to determine important properties of these materials.

Bound in heavy paper cover, the 140-page publication can be obtained from A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa., at $1.25 per copy.

Specifications for Asphalt Cements

Asphalt Institute
801 Second Ave., New York, N. Y.

A new publication sheet, Construction Series No. 64, "Specifications for Asphalt Cements," is now available.

These specifications should be inserted in the manual "Asphalt Pocket Reference for Highway Engineers" and also in the following construction specifications:

A-1. Asphalt macadam surface course.

A-2. Asphaltic concrete surface course.

A-3. Stone filled sheet asphalt surface course.

A-4. Sheet asphalt binder and surface courses.

B-7. Asphalt macadam base.

B-8. Asphaltic concrete base.

CL-1. Cold-laid asphaltic plant-mix surface course.

Copies will be supplied promptly, without charge, on request.

Water Handbook

W. H. and L. D. Betz, Chemical Engrs.
Frankford, Philadelphia, Penn.

A complete handbook on municipal and industrial water arranged in two sections, "Water Analyses" and "Interpretations."

In the first section, 25 different methods of water analyses are discussed at length, with procedures and calculations. Such water analyses as hardness, alkalinity, phosphate, sulfite, turbidity, oil, calcium, specific conductance, etc., are covered. Bacteriological analyses are not included.

The second section of the book is devoted to interpretations of the tests and their application to plant control. Included here are discussions of such subjects as carbonate and non-carbonate hardness, pH control, steam purity, inter-crystalline cracking, corrosion, and many others.

Scattered throughout the "Water Handbook" are sixteen useful technical graphs and fifteen illustrations of different pieces of testing equipment.

The book consists of 64 pages, spiral bound, 8½ x 11"; price 50 cents, postage paid.

Military Roads in Forward Areas. Am. Soc. of Civil Engineers Manual of Engineering Practices No. 23. Prepared by the Society's Committee on Military Road Construction and Maintenance. 85 pp. Price to members, $0.70; to non-members, $1.40.

This is a discussion of the materials and methods most adaptable for military use, as full as was thought desirable for Army use. It deals with the various types of bituminous and cement concrete pavements; equipment; drainage; untreated and treated metaled surfaces; and special road expedients such as metal mesh, corduroy, plank and tread roads. Fifteen pages are devoted to repair, maintenance and improvement of roads, including shell holes, etc.

Conventions and Association Meetings

Sept. 15-16—New England Water Works Association, Hotel Statler, Boston, Massachusetts.

Sept. 18 — Combined meeting of Western Pa. Section of A.W.W.A. and Penn. Water Works Operators' Assn., Hotel Roosevelt, Pittsburgh.

Sept. 21-23—North Dakota Water and Sewage Works Conference, Great Northern Hotel, Williston, N. D.

Oct. 7-9—Combined meeting of Four States Section and N. J. Section of A.W.W.A. and a Section Meeting of Pa. Water Works Operators' Assn. at Benjamin Franklin Hotel, Philadelphia

Oct. 12-14 — Southwestern Section Meeting of the American Water Works Association, Marion Hotel, Little Rock, Ark.

Oct. 18-21—American Public Works Association's Annual Convention, Hotel Statler, Cleveland, Ohio.

Oct. 22-24—Federation of Sewage Works Association's Annual Convention, Hotel Statler, Cleveland, Ohio.

Oct. 27-30—American Public Health Association's Annual Meeting, Municipal Auditorium, St. Louis, Mo.

Oct. 28-30—California Section, A.W.W.A., meets at Oakland Hotel, Oakland, Calif.

Nov. 2-4—North Carolina Section, A.W.W.A., Washington-Duke Hotel, Durham, N. C.

Dec. 2-4—Highway Research Board will hold annual meeting in Hotel Statler, St. Louis, Mo.

The New England Sewage Works Association Fall Meeting, scheduled for September 23 in New London, Conn., has been cancelled and the Association will hold a one-day conference at the Hotel Kimball in Springfield, Mass., on the same day.

H. A. Perry, Jr., Enters U. S. Ordnance Dept.

The Kinney Manufacturing Company, Boston, closed its district office at Dallas, Texas, on August 15th because Mr. H. A. Perry, Jr., the manager, is now in the U. S. Ordnance Department. Correspondence from the district formerly handled by the Dallas office will be taken care of by nearest office or the home office in Boston, Mass.

NEW APPOINTMENTS

New City and County Officials recently reported:

City Engineers

Walter E. Kennedy, Inglewood, Calif.
George L. Pearl, Redding, Calif.
Chas. S. Brown, Greensboro, Ga.
Leon L. Schoel, Spencer, Iowa
P. F. Stuart, Princeton, Ky.
Wallace Howes, Northampton, Mass.
George K. Allen, Rumson, N. J.
T. Carlton Kirkman, High Point, N. C.
J. F. Bivins, Mt. Airy, N. C.
Marion Hagerman, St. Marys, Ohio
Wm. O. Leach, Coleman, Tex.
W. E. Berry, Puyallup, Wash.
B. W. Brown, Moundsville, W. Va.
Richard Buckholz, Nekoosa, Wis.
B. E. Fieve, Stevens Point, Wis.

City Managers

Richard H. Smith, Phoenix, Ariz.
R. W. Rink, Coronada, Calif.
Robert E. Baumberger, Mill Valley, Calif.
Owen Bell, Killingly, Conn.
C. Dorough, Cordele, Ga.
Francis R. Atkinson, Stoughton, Mass.
C. E. Dean, Las Cruces, New Mex.
A. C. Nichols, Wilmington, N. C.
J. S. Butler, Walters, Okla.
Charles C. McCall, West View, Pa.
J. H. Lake, Rapid City, S. D.
James G. Wallace, Kenosha, Wis.

Water Works Superintendents

Dan Kovachevich, Canton, Ill.
Richard Herron, Providence, Ky.
Albert Violette, Rumford, Me.
Arthur Beach, Cambridge, Ohio

County Engineers

C. L. Varian, Ada Co., Boise, Idaho
H. A. Rowland, Ellsworth Co., Ellsworth, Kan.
Lester Allen, Pottawatomie Co., Westmoreland, Kan.
W. G. Henderson, Grayson Co., Leitchfield, Ky.
Lynn B. Wells, Morgan Co., West Liberty, Ky.
C. E. Retallick, Custer Co., Miles City, Mont.
Leo Young, Nueces Co. (Acting), Corpus Christi, Tex.
O. C. Wakefield, Houston Co., Crocket, Tex.

Readers' Service Department

These booklets are FREE but distribution is restricted to those actively engaged in engineering or construction. Use the coupon below or write the manufacturer direct, mentioning PUBLIC WORKS.

Construction Materials and Equipment

Air Raid Shelters

3. New 8 page booklet pictures and describes a corrugated pipe shelter with gas tight end walls, emergency escape tunnel and other desirable features. Armco Drainage Products Assn., Middletown, Ohio.

Asphaltic Limestone

5. Characteristics, methods of laying, and results with cold lay mixture shipped ready to use. Especially adapted to resurfacing old pavements, sealcoats and airport runways. Alabama Asphaltic Limestone Co., Liberty Nat. Life Bldg., Birmingham, Ala.

Bridges

7. Teco Connectors, a new method of structural engineering, to spread the load on a timber joint more equally over the cross-section of the wood is described in new literature available from Timber Engineering Co., Inc., Dept. BS-2, 1319—18th St., N. W., Washington, D. C.

8. Lt.-weight, non-skid, mineral surfaced asphalt planks for any type bridge. Write for latest catalog. Servicised Products Corp., 6051 West 65th St., Chicago, Ill.

Cement Dispersion

9. "Economics of Cement Dispersion and Pozzolith" tells the complete story of how cement dispersion reduces water required up to 20% and increases workability 150%. Write The Master Builders Co., Cleveland, Ohio, for a copy.

Cement, Early Strength

11. 64-page manual tells how to speed up year 'round concreting, shows how to secure high early strength and greater workability at temperatures either below or above freezing. Contains many actual examples of practical concreting operations; well illustrated with more than 60 photos, charts, graphs and tables. Calcium Chloride Assn., Penobscot Building, Detroit, Mich.

Cold Mix Plants

15. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Accelerators

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

33. Pocket manual of concrete curing with calcium chloride. Complete, handy. Contains useful tables, well illustrated. Write the Columbia Chemical Division, Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches — for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

73. "Principles of Design of Airport Drainage" and other articles on airport drainage reprinted from PUBLIC WORKS Magazine are being distributed free by Bowerston Shale Co., Bowerston, O., Hancock Brick & Tile Co., Findlay, O., and Columbus Clay Mfg. Co., Blacklick, O. Address anyone of the above for a copy.

Graders, Patrol

105. The Austin-Western 99M Power Grader with its powerful all wheel drive simplifies all construction and maintenance; handles difficult jobs with economy and efficiency; and does better work on grading, ditching, scarifying, snow plowing, loading, mixing, bulldozing, shoulder trenching and backsloping. Write for Bulletin 1946. Austin-Western Road Machinery Co., Aurora, Ill.

Mud-Jack Method

107. How the Mud Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities — a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Oil

109. Ring-Free Motor Oil that keeps motors clean and free from carbon, and reduces frequency of overhauls is described in literature available from Macmillan Petroleum Corp., 530 West 6th St., Los Angeles, Calif.

Paving Materials, Bituminous

111. New "Tarvia Manual" is packed with useful data on how to build and maintain roads with Tarvia. Each step is illustrated with excellent action pictures, 64 pp. 103 ills. Write to The Barrett Div., 40 Rector St., New York, N. Y.

Pumps

120. Interesting new booklet tells how to lengthen the life of your pumps. Explains how a little care will save a lot of wear. Write today for your copy. Homelite Corp., 2403 Riverdale Ave., Portchester, N. Y.

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from ½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

Road Building and Maintenance

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalogs Nos. 253, 254 & 255, issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

139. "Ironeroller" 3 Axle Roller for extra smooth surfaces on all bituminous work. Booklet contains roller data and operation details. Hercules Co., Marion, Ohio.

140. This well-illustrated 16-page catalog describes the tandem, autocrat, cadet, and roll-a-plane rollers, and explains what each is intended to accomplish. Write Austin-Western Road Mach. Co., Aurora, Ill.

Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated. 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York, N. Y.

152. The Columbia Chemical Division will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information and can be obtained by writing Columbia Chemical Div., Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.

154. "Soil Stabilization with Tarvia"—An illustrated booklet describing The steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Div., 40 Rector St., New Yofk, N. Y.

Spreader

187. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.—4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Surface Consolidation and Maintenance

188. Detailed and illustrated presentation of the method and procedure in consolidated operations; explains how sub-soils can be conditioned to resist softening and frost action; how surfacing can be consolidated to provide smooth all-weather riding surfaces; how they can be

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maintained so as to prevent disintegration and gravel loss. Write the Calcium Chloride Association, Penobscot Bldg., Detroit, Mich., for Bulletin No. 29.

Timber Structures

189. "Typical Designs of Timber Structures" contains plans for 45 representative structures that have been engineered with Teco Connectors. For free copy write Timber Engineering Co., Inc., Room 6GG, 1319—18th St., N. W., Washington, D. C.

Street and Paving Maintenance

190. "Blacktop Road Maintenance and Construction Equipment" — Asphalt and tar kettles, flue type kettles, spray attachments with completely submerged pumps, tool heaters, surface heaters, road brooms, portable trail-o-rollers, etc. Tnese are all described in detail and illustrated. This modern and up-to-date equipment for blacktop airport and road construction and maintenance is based upon experience and engineering research over a period of 42 years. Write for Catalog R. Littleford Bros., Inc., 452 East Pearl St., Cincinnati, O.

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hotstuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Snow Fighting

Snow Plows

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Ice Control

351. "Make Icy Highways Safe for Traffic"—a new bulletin by Michigan Alkali Co., Ford Bldg., Detroit, Mich., tells how to use calcium chloride for modern ice control.

Sanitary Engineering

Aero-Filter

356. "Results Produced by Aero-Filters" is a new pamphlet covering results at Temple, Texas; Paris, Ill.; Webster City, Iowa; and Mason, Mich. Write Lakeside Engineering Corp., 222 West Adams St., Chicago, Ill.

Air Release Valves

357. Automatic Air Release Valves for water, sewage and industrial uses are described and illustrated in new catalog issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

376. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20 pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Chlorinators, Portable

380. Complete data on new portable chlorinator designed to meet emergency calls quickly and efficiently. Write Wallace & Tiernan Co., Inc., Newark, N. J.

381. "Emergency Sterilization Equipment," a new bulletin describing the advantages of Dual Drive Chlor-O-Feeders which can serve as either a permanent chemical feeder or as a portable emergency chlorinator. Order from Proportioneers, Inc., 96 Codding St., Providence, R. I.

Cleaning Mains

382. "Let's Look Into the Matter of Water Main Cleaning" is an illustrated booklet outlining the advantages of water main cleaning and explains how it can be done quickly and inexpensively by The National Method. Write National Water Main Cleaning Co., 30 Church St., New York, N. Y.

Cleaning Sewers With Own Forces

383. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

Consulting Engineers

385. "Who, What, Why" outlines briefly the functions of the consulting chemist and chemical engineer. Covers various methods of cooperation, on different types of problems, with industry, with attorneys and with individuals. Foster D. Snell, Inc., 305 Washington St., Brooklyn, N. Y., will send a copy on request.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. % 96 Codding St., Providence, R. I.

Filters

388. Anthrafilt for increasing filter capacity without adding filters. For full details write H. G. Turner, State College, Pa.

Fire Hydrants

390. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M & H Valve & Fittings Co., Anniston, Ala.

391. See listing No. 410.

Flow Meters

393. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Gates, Valves, Hydrants

394. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

395. Complete booklet with much worthwhile water works data describes fully Ludlow hydrants and valves. Sent on request. Ludlow Valve Mfg. Co., Troy, N. Y.

396. See listing No. 410.

Gauges

398. The full line of Simplex gauges for filtration plants are illustrated and described in catalog issued by Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Manhole Covers and Inlets

402. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., Lafayette Boul. and Indiana Ave., South Bend, Ind.

Meters, Venturi

406. New bulletin illustrates Builders Air Relay system of transmission for the Venturi Meter which is particularly useful for liquids containing suspended solids like sewage. Eliminates corrosion, clogged pipes, etc. Write Builders-Providence, Inc., Codding St., Providence, R. I.

Pipe, Cast Iron

408. Handbook of Universal Cast Iron Pipe and Fittings, pocket size, 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., 386 Fourth Ave., New York, N. Y.

409. Cast iron pipe and fittings for water, gas, sewer and industrial service. Super-deLavaud centrifugally-cast and pit-cast pipe. Bell-and-spigot, U. S. Joint, flanged or flexible joints can be furnished to suit requirements. Write U. S. Pipe and Foundry Co., Burlington, N. J.

410. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., 400 Chestnut St., Philadelphia, Pa

Pipe, Transite

414. Two new illustrated booklets, "Transite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipes. Sent promptly by Johns-Manville Corp., 22 East 40th St., New York, N. Y.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

Pipe, 2-inch Cast Iron

417. Generously illustrated booklet describes McWane 2-inch cast iron pipe and its manufacture in streamlined pipe shop. Write McWane Cast Iron Pipe Co., Birmingham, Ala.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis, Tenn.

Meter Setting and Testing

430. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 48-page booklet you should have a copy of. Ask Ford Meter Box Co., Wabash, Ind.

Reservoirs, Concrete

431. Data on how large reservoirs may be built at a saving as units by the Wm. S. Hewett System of reinforced concrete construction will be sent without obligation. The Wm. S. Hewett System, 20 N. Wacker Dr., Chicago, Ill.

Screens

434. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

Sludge Drying and Incineration

440. "Disposal of Municipal Refuse." Complete specifications and description including suggested form of proposal; form of guarantees; statements and approval sheet for comparing bids with diagramatic outline of various plant designs. 48 pages. Address: Morse Boulger Destructor Co., 216-P East 45th St., New York, N. Y.

442. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Plainfield National Bank Bldg., Plainfield, N. J.

443. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Softening

444. This folder explains the process of Zeolite water softening and describes and illustrates the full line of equipment for that purpose made by the Graver Tank & Mfg. Co., 4809-15 Tod Ave., East Chicago, Ind. Write for a copy of this instructive folder.

Sprinkling Filters

445. Design data on sprinkling filters of Separate Nozzle Field and Common Nozzle Field design as well as complete data on single and twin dosing tanks, and the various siphons used in them, for apportioning sewage to nozzles. Many time-saving charts and tables. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

Swimming Pools

446. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Taste and Odor Control

449. "Taste and Odor Control in Water Purification" is an excellent 92-page, illustrated booklet covering sources of taste and odor pollution in water supplies and outlining the various methods of treatment now in use. Every water works department should have a copy. Write Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y.

450. Technical pub. No. 207 issued by Wallace & Tiernan Co., Inc., Newark, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination, a method of discovering the point at which many causes of taste may be removed by chlorination with little or no increase in residual chlorine. Sent free to any operator requesting it.

451. Powdered Hydrodarco for taste and odor control. For complete data on its use write Darco Corp., 60 East 42nd St., New York, N. Y.

Treatment

453. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

455. New booklet (No. 1642 on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

456. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewerage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia, Pa.

457. New illustrated folder (1942) on Straightline apparatus for the removal and washing of grit and detritus from rectangular grit chambers. Address: Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

458. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, 570 Lexington Ave., New York, N. Y.

459. A combination mechanical clarifier and mechanical digester, The Dorr Clarigester, is explained and illustrated in a bulletin issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

461. Prefloccculation without chemicals with the Dorrco Clariflocculator in a single structure is the subject of a new booklet issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

462. Dorrco Monorake for existing rectangular sedimentation tanks, open or closed, is described and illustrated in a new catalog sent on request. The Dorr Co., 570 Lexington Ave., New York, N. Y.

Valves (See Gates, Air Release, etc.)

Waste Elimination

469. Full information on the Pitometer Survey—a complete check-up on your water plant to reveal hidden sources of waste—will be sent promptly by The Pitometer Co., 48 Church St., New York, N. Y.

Water Treatment

470. If you have a water conditioning problem of any kind, write Graver Tank & Mfg. Co., Inc., 4809—15 Tod Ave., East Chicago, Ind., who manufacture all types of conditioning equipment and will be pleased to make recommendations.

471. Lime specifications and full impartial data on water treatment with lime may be obtained from National Lime Assn., 927 Fifteenth St., N. W., Washington, D. C.

472. Bulletin describes stabilizing lime-softened water by recarbonation, discussing gas production, washing, compressing, drying, and applying the CO(2). Infilco, Inc., 325 West 25th Place, Chicago, Ill.

473. Water Softening. The use of the Spaulding Precipitator to obtain maximum efficiency and economy in water softening is described in a technical booklet. Permutit Co., 330 W. 42nd St., New York, N. Y.

Water Works Operating Practices

490. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Stuart-Brumley Corp., 516 No. Charles St., Baltimore, Md.

Water Service Devices

500. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., will be sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio.

LETTERS
to the Editor

CITY OF COLUMBIA
ENGINEERING DEPARTMENT
Columbia, Missouri

I wish to thank you and your staff for the nice presentation you gave our article on a study of infiltration which appeared in the August issue of PUBLIC WORKS. I also appreciate the check which your treasurer, Mr. Morris, forwarded me.

Our entire engineering force reads with interest the many articles published in your magazine.

Yours very truly,
DEWEY WELCH
City Engineer

HEADQUARTERS CAMP SHELBY
Camp Shelby, Miss.

I am greatly pleased with the appearance of the article, "Destruction of Housefly Larvae and Pupae in Sewage Sludge Beds," by Herbert Spencer, Julius C. Hedden, and Leonard B. Dworsky, Lieutenant Colonel, and Captains, Sanitary Corps, Army of the United States, on pages number 17 and 18 of the August number of PUBLIC WORKS.

* * *

I believe that it will be helpful to me in my present line of work to receive PUBLIC WORKS regularly and I should like, therefore, to subscribe. A check of $3.00 is enclosed for this purpose.

Thanking you, I am

Yours very truly,
HERBERT SPENCER
Lt. Colonel, Sn. C.
Chief, Sanitation Branch

Abel Wolman in U. S. Delegation Sent to Brazil by State Dept.

Abel Wolman, president of the A.W.W.A., recently left for South America as a member of the official delegation sent to Brazil by the U. S. State Department. The delegation is under the chairmanship of Surgeon General Parran of the U. S. Public Health Service. The delegation of six members includes three public health experts in addition to Dr. Wolman and also high official Army representatives. Their mission to South America is to meet with similar governmental representatives of most of the Central and South American countries to discuss problems of public health in particular relation to the war and post-war reconstruction.

Fred W. Hartmann with Corps of Engineers

Fred W. Hartmann, assistant district manager in charge of the Chicago water works division for Pittsburgh-National Meters, has been given an indefinite leave of absence so that he might serve with the country's armed forces.

On May 7, 1942, he was inducted into the Corps of Engineers, United States Army, with the rank of captain.

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